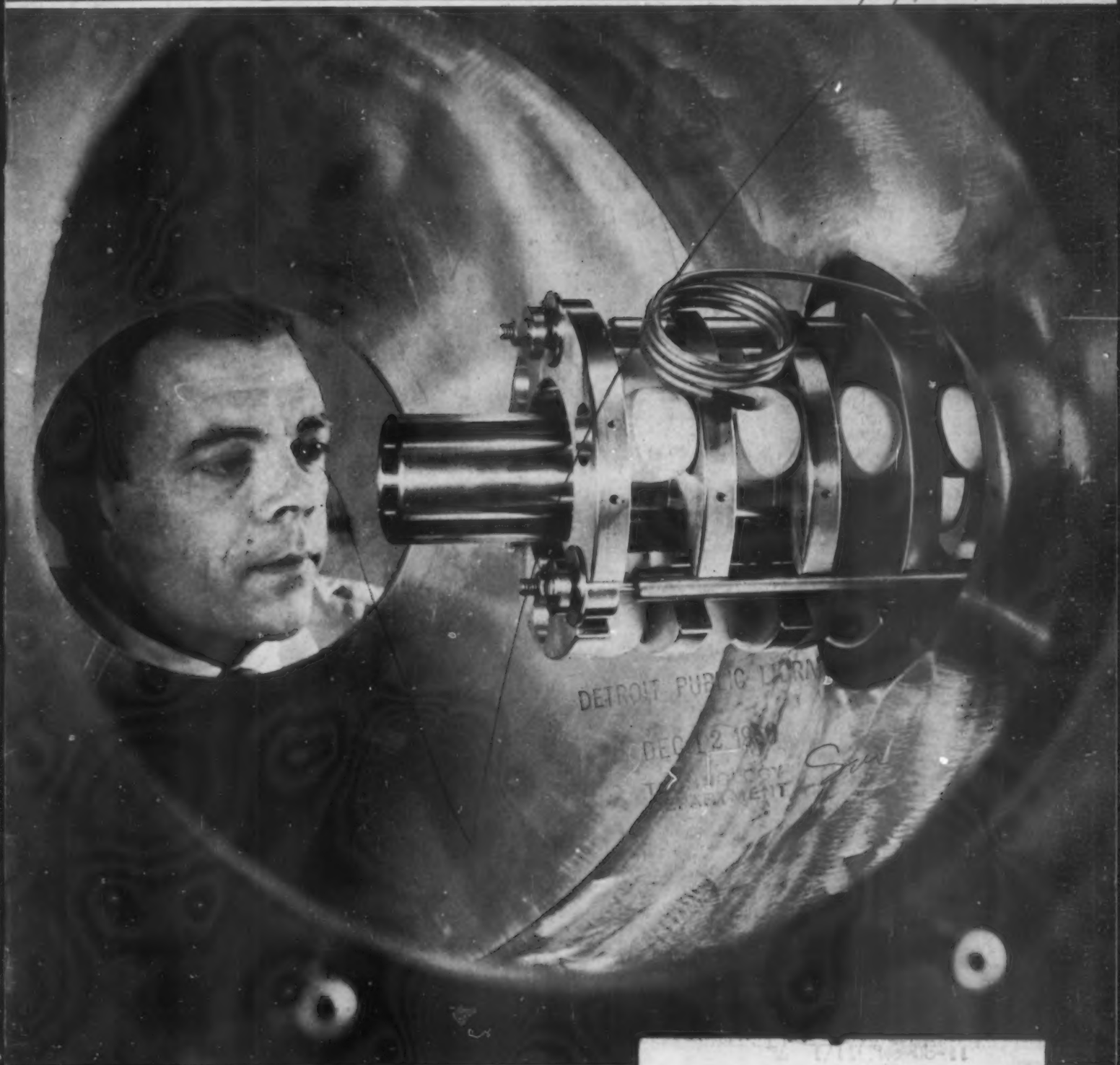
DECEMBER 12, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY



Ion Engine in Man-made Vacuum at Goodrich

Cuba Crisis Revives Launch Ship Plan . . .
Will Civil Defense Be Put Under DOD? . . .
New Glass Fiber Stirs Wide Interest 23

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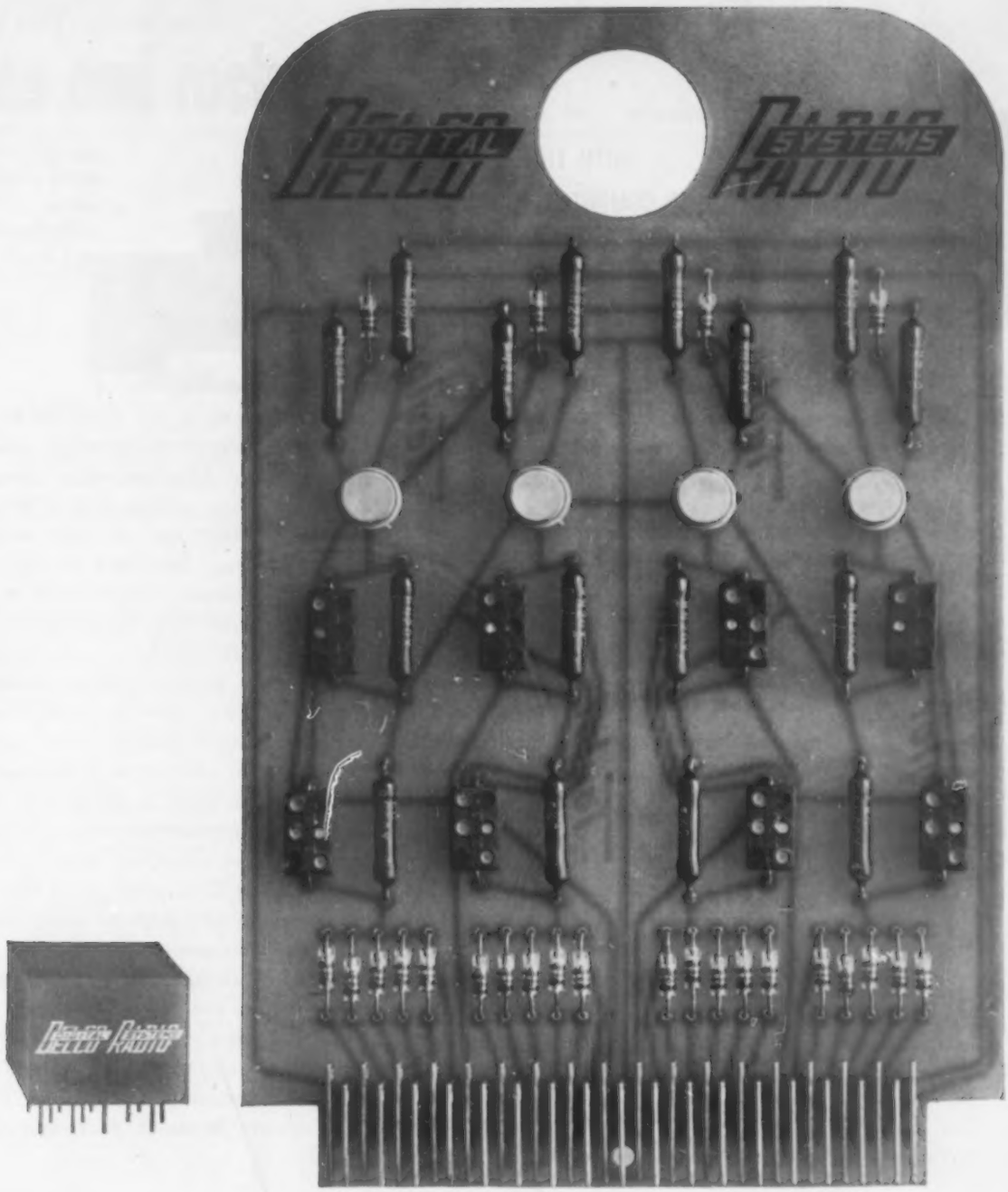

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THE MISSILE/SPACE WEEKLY

missiles and rockets

Volume 7, No. 24 December 12, 1960

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THE COVER

Ion engine is installed in vacuum tank at B. F. Goodrich Co. for test of performance under extra-terrestrial conditions. Engine was shown at annual ARS meeting last week.

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*U.S. Reg.
†U.S. Reg. Pdg.

31,975 copies this issue

—letters—

Russia and F.A.I.

To the Editor:

I have just received a copy of MISSILES AND ROCKETS for November 21, in which on page 35 there is an article concerning the new Regulations issued by the Fédération Aéronautique Internationale on the subject of record attempts in manned rockets.

I greatly regret to note the anti-Russian bias of your article, particularly the title. It may not matter to you or to your Paper whether or not offence is given to any country, but it does matter to our Federation in which the Russians, the Americans and all the other countries are Members with equal rights and equal obligations.

The rules to which you refer were agreed upon mutually by the Russian and U.S. delegates at our Conference. They were not devised for the purpose of obtaining secret information from the U.S.S.R. No one is obliged to register a record and, in fact, many performances are reported in the Press from time to time which appear to be superior to some of the existing records registered by the F.A.I.

We all know that Governments refuse to release technical details about the aircraft which have established these performances, but any person, organization or country which wishes to set up a record for registration by the F.A.I. knows that they must supply the information called for in the F.A.I. Sporting Codes. Therefore, there is no question of the Russians or anybody else being "put on the spot."

H. R. Gillman
Director General
Federation Aeronautique Internationale
Paris

M/R's story did not say that the new F.A.I. regulations were drawn up with the intention of putting the U.S.S.R. on a spot. But don't they?—Ed.

Bullpup Numbers

To the Editor:

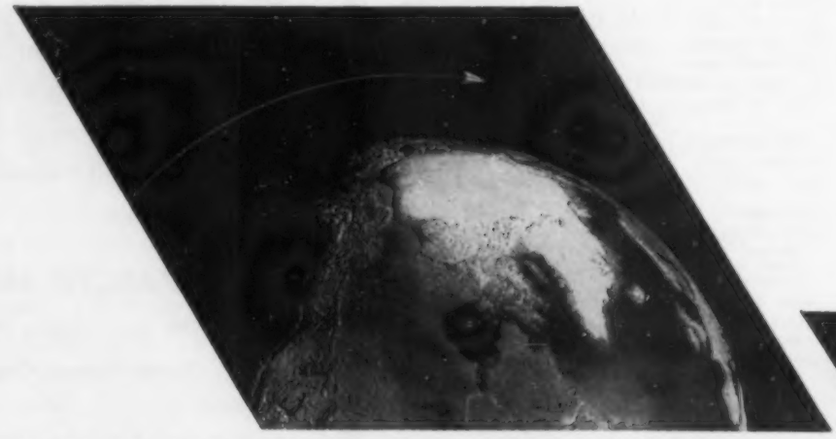
I noticed with interest the story in your issue of September 19, "Standardization Cuts Cost of Bullpup Support."

There was only one thing wrong with the ground support equipment story. In the first paragraph you refer to GAM 63. I know the missile business is a numbers game and that it was probably a typo, but the official designation is GAM 83. It is not an error of great importance and it is one of the rare ones your staff has made.

Thanks for your interest in Bullpup.

Julian Levine
Information Services
The Martin Co.
Orlando, Fla.

Engineers Mathematicians Physicists



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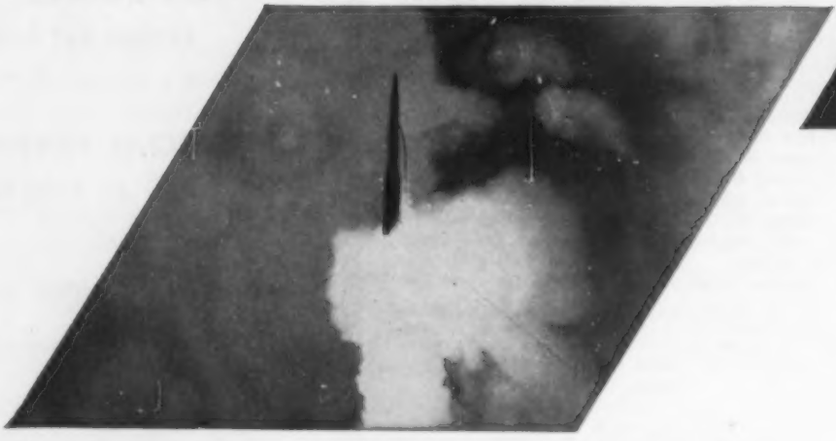

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If the answer to following three questions is "yes," explain on supplementary sheet:

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3) Have you ever received disability or accident compensation?_____

TURN PAGE ➡

HIGHER EDUCATION

College and Location	Dates Attended	Degree and Major
1.		
2.		

EMPLOYMENT HISTORY

Firm Name and Address	Base Pay 40 hr/Wk	Dates Employed Month/Year
1.		
Position & Duties		
2.		
Position & Duties		
3.		
Position & Duties		
4.		
Position & Duties		

REFERENCES. Give full names, occupations and addresses.
Professional (previous supervisor preferred):

1. _____

2. _____

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1. _____

2. _____

LIST TYPE OF WORK PREFERRED UPON EMPLOYMENT:

_____

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Have you ever been cleared for classified military information?_____. If yes, give date, level and company.

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If "yes", I authorize, without liability, the release of all employment and personal information.

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Application form begins on previous page.

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BOEING

The Countdown

WASHINGTON

Fixing the Missile Pie

No amount of Pentagon reshuffling will eliminate one of the tougher decisions confronting President-elect Kennedy in January: the ICBM "mix." DOD planners are saying that 1961 is the year that the composition of the missile force must be determined for years to come. Commitments must be made on just how many ICBM's will be mobile and how many will be in fixed sites; whether there will be a large or nominal fleet of *Polaris* submarines; or just a few hundred *Minutemen* or more than a thousand. Otherwise the missiles won't be ready in the missile gap years 1963-64.

Targets vs. Targeters

Talk of "reducing" the number of Soviet targets is considered by those on the inside to be highly erroneous. Actually it's the other way around. The targets remain the same. But what joint target planners are trying to do is cut down on duplication by unified commands who have assigned themselves many of the same places to hit in wartime.

ICBM Unit Costs Rise

Latest Air Force ICBM price list puts a $13.7-million tag on one ready-to-shoot *Atlas* in a 1 by 12 hardened and dispersed squadron configuration. *Minuteman* per silo now is pegged at $3.4 million (up $1.4 million from previous estimates). R&D is prorated in both price figures.

Army/NASA High Altitude Research

Electron density and other physical properties above 700 miles will be investigated jointly by the Army's Ballistic Research Laboratory, Aberdeen, Md., and NASA. BRL, which has dropped the *Strongarm* sounding rocket, will design the payloads to go aboard NASA's *Argo D-8* for the probes.

Underwater Intelligence

Navymen are wondering if they can keep tests of a new one-million watt underwater transmitter secret. The transmitter is going aboard a converted freighter, reportedly as part of the *Artemis* ASW project. The secrecy problem: testing the transmitter is expected to "kill one helluva lot of fish."

INDUSTRY

Dyna-Soar: Off-shelf Guidance?

COUNTDOWN is told that the Air Force is shopping hard for an off-the-shelf guidance system for *Dyna-Soar*. This has considerably broadened competition for the soon-to-be-let contract. AF apparently is intent upon moving to test flights as soon as possible.

Polaris Production

Talk is dying of a second source for *Polaris* missile fire control. GE has the contract and is said to have the production capacity to meet present submarine construction schedules. However, missile production schedules are forcing the Navy to go to more than one source. One of the big tussles to be decided soon is whether GE or Raytheon will get the guidance system contract for the 2500-mile *Super Polaris*.

Aerospace Corp.'s Plant

For those who have been wondering, the AF tells COUNTDOWN that the financial history of Aerospace Corp.'s new plant in El Segundo, Calif., goes like this: Ramo Wooldridge built the plant. Space Technology Laboratories then acquired it. The AF is paying STL for the facility.

Mahogany Row

North American President J. L. Atwood is now chief executive of the company, taking over from Board Chairman J. H. (Dutch) Kindelberger who will keep his title but devote his time to policy and planning . . . Sanders Associates, Nashua, N.H., electronic firm, is moving its Navy *Eagle* air-to-air missile target-seeking work to a new plant on Boston's Route 128—the "Golden Semi-Circle."

Boeing Earnings Up

With 30% of its business in missiles, Boeing Airplane Co. estimates 1961 earnings of about $4 per share—up from this year's estimated $2.75-$3 . . . Space Recovery Systems of Los Angeles, jointly owned by Steinthal & Co. and CBS Laboratories is being purchased by Itek Corp . . . and Bendix Corp. is continuing its expansion plans with the acquisition of Micrometrical Mfg. of Ann Arbor, Mich.

Davy Crockett's Weakness

Army brass is said to be worried over possible unwarranted or premature use by infantry of its portable *Davy Crockett* missile, which is nuclear-tipped. They feel some sort of "positive control" is needed without destroying the effectiveness of the weapon as a "handy" item. Just what the answer will be isn't apparent.

INTERNATIONAL

Sylvania Taking Over Thorn?

Rumors buzzing through London financial circles have U.S. Sylvania making a bid to take over Thorn Electrical Industries, one of Britain's biggest electronic firms. Thorn is denying it, but . . .

Scout Abroad

NASA is negotiating with France, Germany, Italy, Japan and Australia to put their instrumentation in *Scout*-launched satellites. Discussions are also in progress with Norway, Sweden and Argentina. But so far the only firm agreements are with the United Kingdom and Canada.

Soviet Foot-dragging

Russia is still holding up formation of the U.N. Committee on Peaceful Uses of Outer Space (M/R, Oct. 24, p. 12). However, Secretary General Hammarskjold is said to be trying to force the issue to a head in the next few weeks. Set up in 1959, the committee has yet to hold a meeting.

Overseas Pipeline

Some British scientists are pushing for a satellite launch vehicle composed of a *Blue Streak-Black Knight* with a LOX-liquid hydrogen third stage. But there is still no indication whether the government will commit itself to a space program . . . The British Admiralty has ordered *Sidewinders* for its Scimitar fighters . . . *Paris Match* reports the return of French Naval Secretary Le Bigot from a U.S. visit of *Polaris* missile and submarine research and production centers.

How to double performance of your magnetic tape recorders

Now you can record 125-kc data at 30 ips instead of 60 on most existing data recorders. How? By using the new Ampex FR-600 for playback. New record/playback capability in the FR-600 saves previous equipment from obsolescence with some added benefits of its own—for example, recording 500 kc at 120 ips.

Your curiosity whetted? Write:

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The Missile/Space Week

Elevator Seen as Possible Cause of Titan Blast

A possible failure in the elevator mechanism or human failure appears to have caused the blast that ripped the *Titan* R&D launching silo at Vandenberg AFB during a missile loading test this last week.

There was no immediate determination on what effect the accident would have on the *Titan* program. However, Air Force officials expressed the hope that the first *Titan* squadron will still be operational on schedule in mid-1961.

The explosion occurred when a fueled *Titan* was being lowered into the silo by the giant elevator. The big missile was halfway in when it suddenly appeared to drop the rest of the way. Flames spouting from the silo could be seen for miles; the blast was felt 20 miles away.

There was speculation that someone may have punched the wrong button.

Damage to the silo was so great that it was generally considered a total loss. A four-level underground equipment terminal and an underground propellant terminal some 40 feet on either side of the silo were reported to be wrecked.

However, there is a second *Titan* silo complex at Vandenberg available for test launchings.

Polaris, X-15 and Snark

Polaris II is nearing the day when it will reach out 1500 nautical miles. The second Lockheed R&D *Polaris II* to be launched roared 1400 nautical miles down the Atlantic Missile Range Dec. 5.

The Air Force said farewell to the *Snark* R&D program the same day. The last Northrop R&D *Snark* flew 5000 miles over the Atlantic.

Test Pilot Scott Crossfield successfully flew the *X-15* with its powerful new XLR-99 engine for the third time Dec. 6. The rocket plane roared across the California desert at full power some 10 miles at about 60,000 feet.

France To Join 'Nuclear Club'

The French Assembly approved President De Gaulle's plan to build a French nuclear striking force of bombers and missiles. The action came less than two weeks before the NATO conference on creating a separate NATO nuclear force.

SCOUT launching fails . . .

NASA Faces Schedule Quandary

A backup payload is available for another attempt at orbiting a "baby *Echo*" air-density drag satellite with the next *Scout* launch vehicle test early in 1961.

Scout-3, the first orbital attempt with the low-cost all-solid vehicle and the first attempted satellite firing from NASA's Wallops Island station, failed to orbit Dec. 4 when the second stage either failed to ignite or did not receive the signal to ignite.

The vehicle plunged into the Atlantic about 80 miles downrange. It was the first failure in dozens of firings for the second-stage *Castor,* a Thiokol motor similar to the Army's *Sergeant.*

The NASA schedule calls for launching *S-55,* a micrometeorite measuring satellite, with the next *Scout* in early 1961. *Scout-5,* programed for the second quarter of the year, is a backup vehicle. The question now is whether to juggle *S-55* and the backup air-density balloon.

Dozenth Discoverer Orbited

The Air Force on Dec. 7—the 19th anniversary of Pearl Harbor—successfully launched *Discoverer XVIII* into a polar orbit and prepared to attempt a retrieval off Hawaii. The 2100-lb. satellite, twelfth in the series to go into orbit, had an apogee of 450 miles and a perigee of 150 miles. It was powered at takeoff by a *Thor* with a 165,000-lb.-thrust engine, souped up beyond the previous 150,000 lbs. An *Agena* second-stage gave it its final kick.

The Air Force declined to say whether the satellite carried any "sky spy" cameras or other surveillance equipment. They did announce that its recoverable 300-lb. capsule carried human bone marrow, blood cells and a membrane from a human eyelid to check the effects of radiation on man.

Linde Will Make NASA's Liquid Hydrogen

Linde Co. division of Union Carbide last week won a sharply contested $31-million contract for supplying NASA with up to 60 million lbs. of liquid hydrogen through 1966.

Linde will build a new plant at Fontana, Calif., which will go into production in mid-1962. Until then Linde will supply transportation of NASA needs in liquid hydrogen on the West Coast from the Air Force plant at West Palm Beach, Fla., operated by Air Products Inc.

All of the liquid covered by the contract, signed Monday afternoon, will supplement an estimated 3.3 million lbs. produced by a Linde plant opened last summer at Torrance, Calif.

Air Products and Shell Chemical Co. were the other bidders.

Sputnik 'Failure' in Perspective

Biomedical leaders meeting in Washington, D.C. reiterated the opinion that the USSR may be at least 3 to 5 years ahead of the United States in putting living systems into orbit, in spite of the recent Soviet *Sputnik's* hapless fate. The five-ton spaceship, heaviest vehicle ever orbited, carried two dogs and numerous other biological experiments destined to predict the effects of space travel on man. The vehicle apparently malfunctioned during re-entry and disintegrated in the atmosphere. Presumably the ship was to slow down, eject the biomedical capsule, then land itself as *Sputnik V* was supposed to have done. Trackers estimated that the ship made 17 or 18 passes in an elliptical orbit 115 miles at perigee, 164 miles at apogee at an inclination of 65°.

Zeus Passes Test

GUIDANCE of the Nike-Zeus A-ICBM checked out successfully in its first test shot on Dec. 1 at the White Sands Missile Range. Army is now pressing for "interim production" of the defense weapon.

Disarmament a Bogeyman?

Disarmament would not topple the defense industry, Martin Co. president William B. Bergen told the New York Society of Security Analysts. As much or more business could develop for space projects, with programs such as *Apollo* coming in line for extra support. In another burst of independence, General Electric announced plans to start exploration and economic development of space without government contracts. However, President Ralph J. Cordiner made it clear that GE had no specific space project that could run by itself now, and government contracts would keep GE's resources occupied at least two or three years.

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Ordnance
Research
Development

SS-11 MISSILE
ONE MAN TANK KILLER

Nord's SS-11 is the only anti-tank missile with a warhead able not only to pierce, but to destroy and smash, any existing tank. Effective ground-to-ground or air-to-ground, the SS-11 can be launched by one man. Accurate between 800 and 3,600 yards, the SS-11 speeds to its target at 425 m.p.h. Operational for 3 years.

NORD-AVIATION

2-18, rue Béranger
CHATILLON-SOUS-BAGNEUX
(Seine) France

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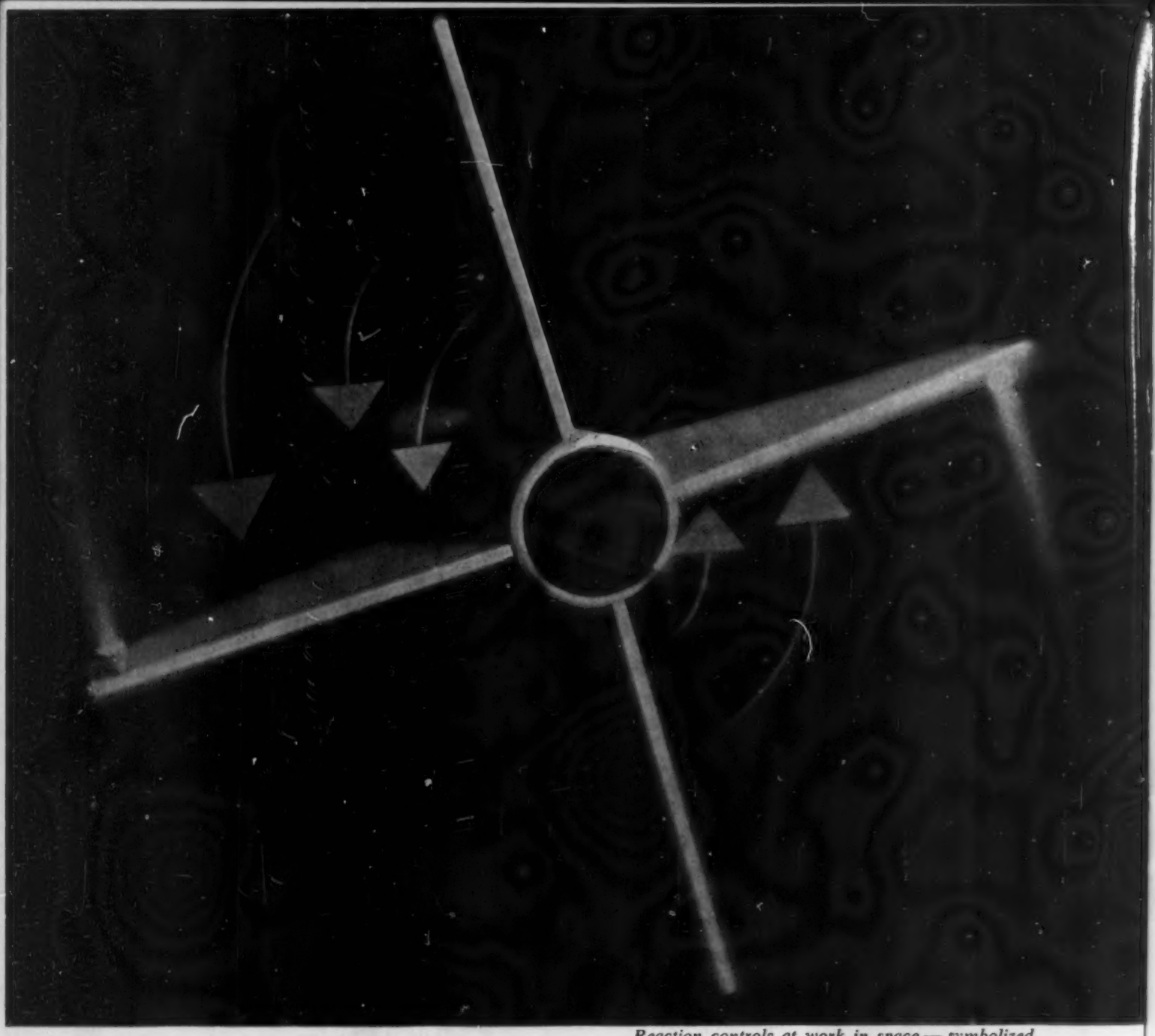

Reaction controls at work in space — symbolized.

STEERING GEAR FOR ASTRONAUTS

Conventional aircraft control surfaces will not guide space ships and capsules. Rudders, ailerons and elevators find no resistance and hence produce no reaction to their movements where there is no atmosphere. Even at altitudes only half way up, they are sluggishly ineffective.

The accepted answer to a dependable steering mechanism for astronauts is a system of jet reaction controls developed and produced by Bell Aerosystems Company. First used on Bell's own supersonic X-1B several years ago, the system has been greatly improved and adopted for the X-15, the Mercury man-in-space project and other space vehicles.

Through strategically located, low and high thrust (1 to 1500 pound) rocket engines, Bell's reaction controls not only position and guide the ship by controlling the roll, pitch and yaw, but they also provide for orbit changes and retro-thrust. Some of the jets are throttleable while others can be operated in combination to provide the astronaut positive and flexible control.

This revolutionary steering gear for space, available using monopropellants or high energy bipropellants, is just one of many advanced projects which are currently engaging the diversified talents of Bell Aerosystems Company in the fields of rocketry, avionics and space techniques. Engineers and scientists seeking challenging, long-range career opportunities can find them at Bell.

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BUFFALO 5, N. Y.
DIVISION OF BELL AEROSPACE CORPORATION
A TEXTRON COMPANY

Cuban Incident . . .

New Look at Launch Ships

Diplomats aid fight for 'pads' at sea

by James Baar

THE NAVY'S PROPOSED satellite launching ship—shelved by the Administration's still-secret final budget—is picking up strong new support because of the recent rain of U.S. rocket fragments on eastern Cuba.

The State Department appears to be pressing the Pentagon to find some way to avoid launching rockets from Cape Canaveral in trajectories that pass over Castro's Red-dominated island.

At the same time, proponents of the satellite launching ship are understood to have begun a new drive in the Pentagon to squeeze the $30-million program into the Navy's tight new budget for FY 1962. They are arguing that the ship is needed not only for R&D work but as the operational platform for a spacecraft interceptor weapon system.

• **Charges stir 'concern'**—The rocket fragments fell on an uninhabited area of Cuba after a *Thor AbleStar* carrying the *Transit IIIA* navigation satellite was destroyed by a safety officer shortly after the booster was launched Nov. 30 from Cape Canaveral. The *Thor AbleStar's* planned trajectory passed over Cuban territory.

Revolucion, the official mouthpiece of Castro's revolutionary organization, said: "This is a new Yankee provocation, a new demonstration of the contempt of the Pentagon military for the life and security of other people."

The State Department, in discussing the incident with the Pentagon, is reported to have taken the position that:

–If fragments from another U.S. missile should cause damage in Cuba, the Castro propaganda machine could whip up more anti-U.S. sentiment in Latin America and cause other difficulties.

–The Pentagon should stop launching rockets over Cuba if at all possible.

So far, the Pentagon has declined to comment beyond stating that an investigation is underway and that Pentagon officials are "concerned."

Asked if the United States were considering cessation of rocket launchings over Cuba, a Pentagon spokesman said: "We have nothing to add to what we said earlier."

• **A second look**—However, behind the scenes, officials were taking a new look at Navy proposals for seaborne missile pads including the launching ship.

Earlier, the Navy specifically considered including the first of possibly two satellite-launching ships in the FY '62 budget (M/R, Aug. 1). However, the proposal was dropped by the Navy in favor of squeezing other items considered to have higher priority under the tight budget ceiling lowered by the outgoing Eisenhower Administration.

The ship probably would be a converted Currituck Class seaplane tender. Cost of converting the 9000-ton ship and equipping it is estimated at about $30 million.

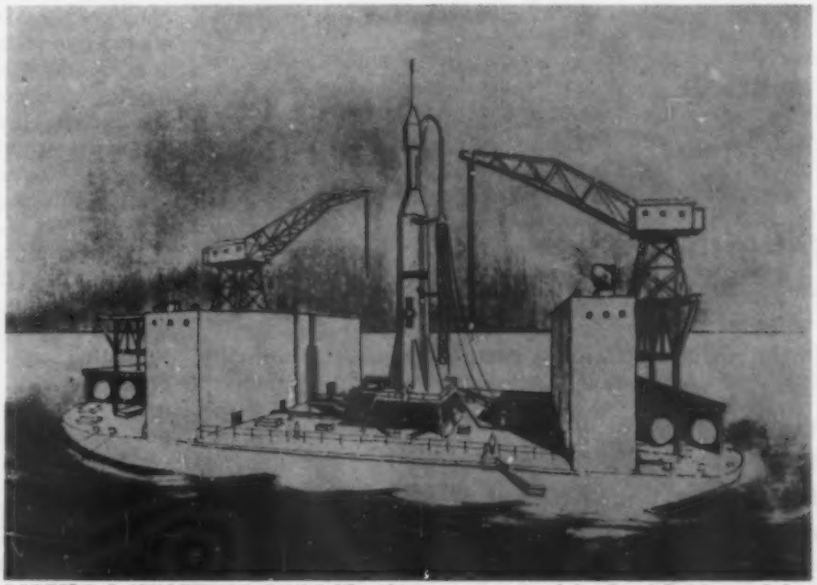
The ship would be a mobile miniature Cape Canaveral capable of launching boosters with up to about 200 lbs. of payload. One of its first assignments would be the launching of the Navy's *Transit* navigation satellites. However, it also could be used as part of a task force to launch anti-satellite missiles.

The cost of a mobile launching ship compares favorably with the cost of constructing similar land-based facilities. The construction of what is described as an "austere" R&D launching pad complex for an *Atlas* is officially estimated at about $40 to $50 million. A similar *Thor* complex for launching satellites is estimated at slightly less.

• **Drydocks available**—Besides the proposed launching ship, the Navy also has been considering proposals for constructing seaborne launching pads for much bigger boosters by converting floating drydocks.

The drydocks—placed in mothballs after World War II—could be used separately or joined together, depending on the size of the boosters involved. The docks could be towed to any sheltered water in the world to provide mobile equatorial launching sites.

Both the satellite ship and the floating dry dock would give the United States the capability of launching payloads into any desired orbit without launching over U.S. or foreign soil or paying the severe, costly penalty of dog-legging trajectories with restartable rocket engines. ■



MOBILE LAUNCHING PADS like this one conceived by Daniel, Mann, Johnson & Mendenhall can be constructed from the Navy's mothballed floating drydocks.

ARS Meeting

Advance Into Space Seen Major U.S. Goal

Speaker blasts policies of Defense and Industry alike; Von Karman heads list of annual award winners

CLEARLY THE NEXT ADMINISTRATION must make the conquest of space a major national goal.

This course was laid down before the 15th annual American Rocket Society meeting in Washington last week by peppery Dr. Abe M. Arem, who challenged the Kennedy Administration to tell the reasons for this goal "loudly enough to gain the support of every U.S. citizen."

Zarem, president of Electro-Optical Systems being suggested as the next head of NASA, methodically scorched:

–DOD for "wasting creative talent" in industry by its procurement policies.

–Industry for failing to "change its ways from progress by inches to progress by miles."

Denouncing American industry as "fat and lazy," the short and hefty ARS director said "research . . . is not seen in its true light as a creator of knowledge, wealth and power."

DOD's procurement system, he said, "is like a gigantic bowl of wet noodles. Trying to get something done is like pushing one end of any of the noodles. No one knows where the noodle is connected—where it goes in the mess—and what if anything will move."

• **Manned satellites**—A large number of papers read at the meeting stressed the need for manned orbital rendezvous if we are to put a man on the moon by the early 1970's. Space rendezvous attempts could be made with unmanned craft in 1961 or 1962, one scientist said, but it will be 1964 before manned craft will be able to meet in space.

International space laws, too, must be formulated in the next few years, to go along with the expected rise in space activity. Although it's too early for a detailed and comprehensive code to govern the use of outer space, according to a report made to NASA by the American Bar Foundation, sooner or later space law must face the problem of rights and prohibitions.

House Space Committee Special Counsel S. M. Beresford told the meeting that there may be as many as 50,000 space launchings by 1975 and that nations must get together on rules governing liability for injury or damage caused by launchings.

Besides technical presentations, other speakers covered more mundane subjects. One innovation this year was the inclusion of two days of panels devoted to marketing, advertising, and public relations in the Space Age. Included in this was a warning to aircraft manufacturers that they must concentrate on areas of the military market that are destined to grow, maintain systems management capability, and expand their marketing horizons.

The space field's highest honor—the ARS Robert H. Goddard Memorial Award—was presented at the annual banquet to Dr. Theodore Von Karman, pioneer in aeronautical and astronautical research and chairman of the NATO Advisory Group for Aeronautical Research and Development.

Other awards presented:

• **ARS Propulsion Award**—Dr. Ernst Stuhlinger, supervisory physical chemist, NASA Marshall Space Flight Center, for his work in rocket power.

• **James H. Wyld Memorial Award**—Robert L. Johnson, chief engineer, Douglas Aircraft, Missiles and Space Engineering dept., for contributions to *Thor* IRBM development.

• **G. Edward Pendray Award**—Prof. Luigi Crocco, Princeton University, for outstanding contributions to rocketry and astronautics literature.

• **ARS Astronautics Award**—Scott Crossfield, pilot-engineer of *X-15*, for achievements in manned space-flight.

• **ARS Chrysler Award**—Julian I. Palmore, Cornell University student, for his paper on a lunar impact probe.

• **ARS Thiokol Graduate Student Award**—Richard J. Hayes, James M. Glassmeyer, and Charles A. Huebner, MIT graduate students, for their paper on the duo-plasmatron ion rocket.

Goodrich - High Voltage Astronautics exhibited a model of an ion engine and electrostatic generator which has produced thrusts of 10-multi-pounds with an isp range of 10,000 seconds and a power efficiency in excess of 90%.

Aerojet-General Nucleonics announced production of hydrozine by "fissio-chemistry" in a nuclear reactor.

Westinghouse released the first information on its "thermally activated ceramic/metal combinations" which, when heated, produce an electrical output. Research is aimed at a 5-10 lb. per kwh unit.

Over 3500 scientists, engineers and technical personnel registered for the technical sessions this year. Some 163 papers were presented in 35 different sessions. An additional 2000 people visited the Astronautical exhibition. ⌘

Technical Highlights

- ***All-solid "modular" rockets for quicker and cheaper space missions***
- ***Commercial Communications satellites ready for launch within year***
- ***New sodium/lithium engine for underwater propulsion***
- ***Saturn GSE ready to go despite problems***
- ***Minuteman silo launch test phase ahead of schedule***
- ***Composites can meet demands for high-temperature materials***
- ***New techniques for space guidance***

(See page 35 for resumes of these and other significant papers.)

Congress disposes . . .

Sweeping Defense Changes Proposed

by Clarke Newlon

EXTENT OF the Kennedy Administration's efforts to lift the U.S. military organization from the concepts of World Wars I and II into the Space Age may depend upon how much of a proposed reorganization can be accomplished by executive order and how much will require Congressional action.

Conclusions of the Symington Committee handed to the president-elect last week call for sweeping alterations in the military structure. They would entail major legislative and executive changes. The changes, most of them forecast by M/R (Nov. 14 issue, p. 8), include:

–Elimination of the present departmental structure of the Army, Navy and Air Force, while preserving the Services as separate units within a single Defense Department.

–Elimination of Service Secretaries, assistant and under-secretaries—15 in all.

–Abolition of seven existing offices of Assistant Secretary of Defense.

–Creation of two new Under Secretaries of Defense, one for Weapon Systems and one for Administration.

–Creation of a Special Assistant to the Secretary of Defense for Arms Control, to serve as liaison in that area with the State Department.

–Reconstitution of the Chairman of the Joint Chiefs as Chairman of the Joint Staff, making him chief military advisor to the Secretary and, in effect, the chief military officer of the nation.

–Establishment of a Military Advisory Council composed of senior officers of all Services, to be appointed by the President. These officers would have no responsibilities to their own services and would not return to their own services. The Chairman of the Joint Staff would preside over the Council.

–Redesignation of the Service Chiefs as responsible for support of unified commands. Chiefs would not serve on either the Joint Staff or the Council.

–Establishment of the following unified commands:

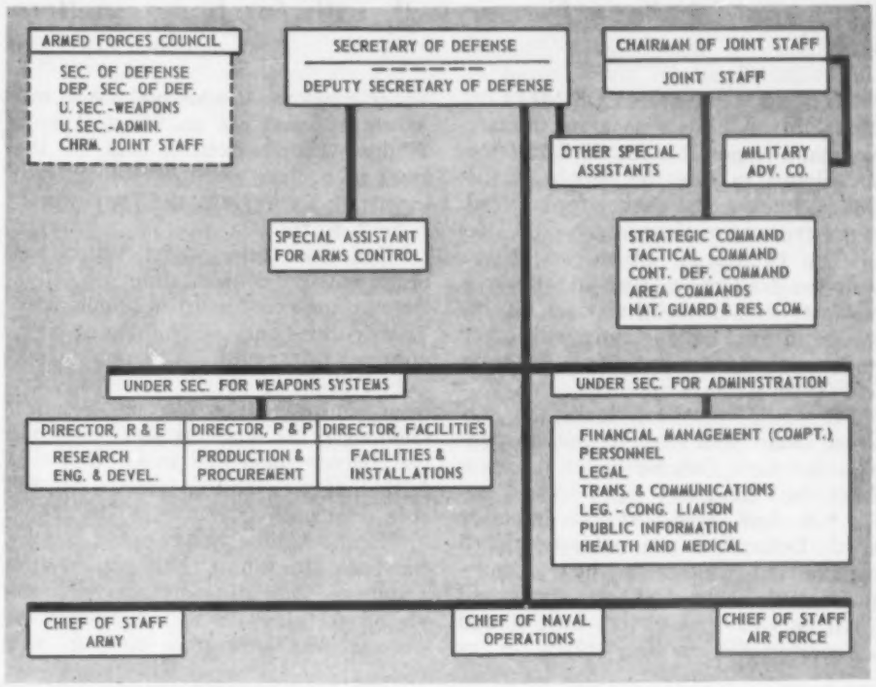
1. A Strategic Command, responsible for all strategic missions.

2. A Tactical Command, responsible for all limited and conventional defense missions.

3. A Defense Command, responsible for all continental defense missions.

4. Certain Area Commands (such as Pacific or Atlantic) as needed.

5. A command in charge of the National Guard and Reserve elements of all Services and responsible for Civil Defense.



SYMINGTON COMMITTEE which drew up defense reorginazation recommendations for President-elect Kennedy submitted this chart illustrating proposed structure.

• **'Piecemeal' efforts scored**—The National Defense Act which established the Department of Defense was passed in 1947. It was amended in 1949, put through a major reorganization in 1953, and amended again in 1959.

The Symington Committee, composed of the Missouri Senator and five former government officials (three from the DOD) and named by Mr. Kennedy after his nomination, pointed out, however:

"The piecemeal amendments . . . did not alter the essential character of the U.S. military organization, deployed on the basis of whether a military man travels on land, sea or air. Hence it can be truly said that since 1947 there has been no fundamental change in the scheme of organization of our armed forces.

"Yet during this period of nearly a decade and a half, the whole state of the art in military science has been revolutionized, as epitomized in the transitions to the jet, nuclear and space ages."

• **Trouble in sight**—While the committee was saying in effect, "don't try to prepare for the next war on the basis of the last," most Capital observers nevertheless felt that some of the proposed changes would be opposed by many Congressional leaders, and military officials, for that matter.

How much of the National Defense Act would have to be further amended is a much-discussed question. A new President, for instance, could abolish Service Secretaries by simply not appointing them. This would bring up the difficulty that the Service Secretaries have to approve all Service procurement. Other changes which might be made by Presidential order could conceivably run into Congressional withholding of funds.

Most likely to happen: a compromise which would abolish many of the Pentagon's civilian layers and go much further than the Services yet have gone in joint or unified commands; upgrading the power of the Secretary of Defense and the Chairman of the Joint Chiefs—but providing no single Chief of Staff. ⌘

Kennedy Should Put Civil Defense under

An expert hails reorganization proposal as the only realistic hope for survival, calls for home shelters

by Pat Frank

THE SYMINGTON COMMITTEE PLAN to establish a separate military command responsible for Civil Defense is designed to give the people of the United States a real chance for survival in the event of nuclear war.

The Command, which would absorb the National Guard and Reserve elements of all three services, is intended to have equal stature with other major commands—including Strategic and Tactical.

It would, in effect, make the National Guard and Reserve units responsible for Civil Defense under direction from the Pentagon.

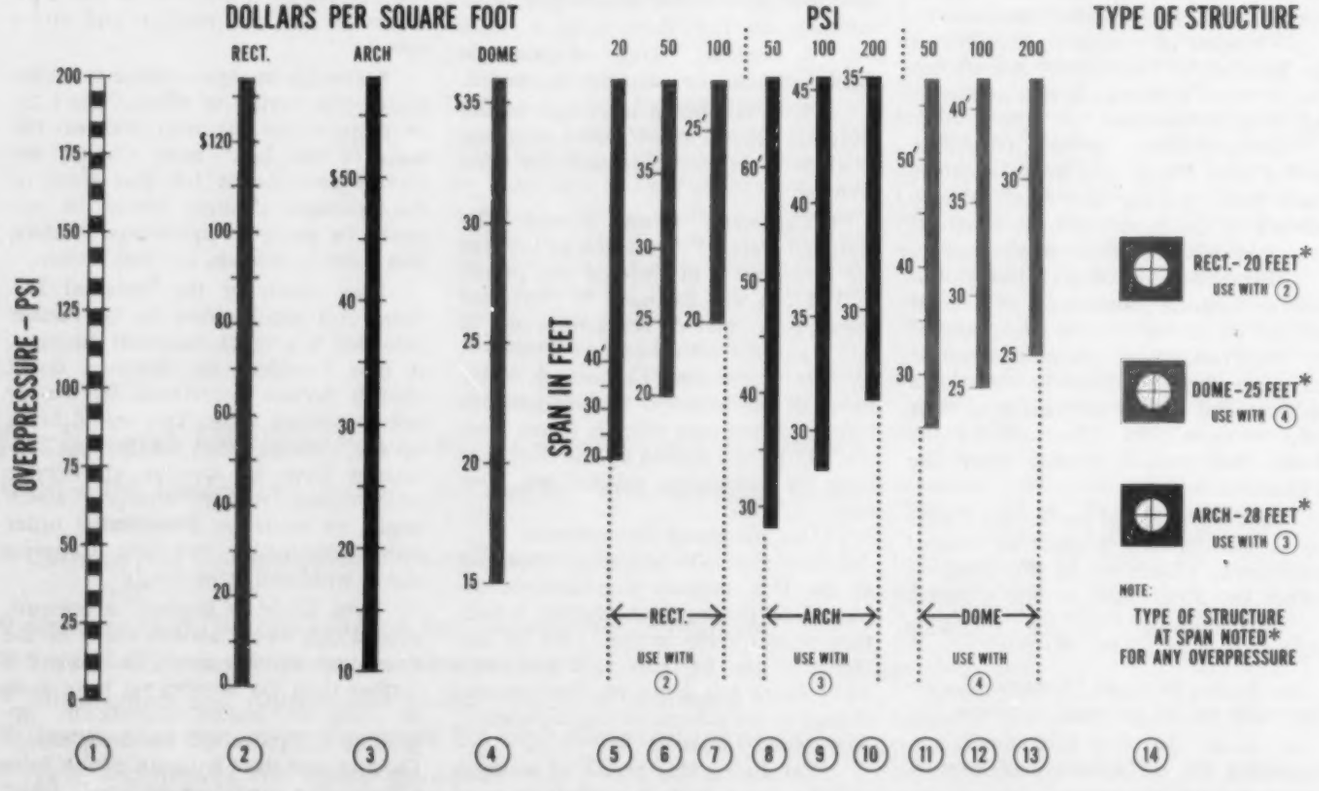
• **A frail reed**—At this moment Civil Defense is an undernourished orphan of government, inept, inadequate, and scorned. Lame ducks and Civil Service time-servers have found a comfortable roosting place in its higher echelons. It adds nothing to our deterrent power. If anything, it is a liability. People believe that in the event of nuclear war they will be protected by Civil Defense. They won't; it can't do the job.

Conversely, the Soviet Union has been quietly concentrating on Civil Defense training for urban populations. Twenty-two hours of training is compulsory for adults in target areas. Public shelters, deep and large, have been constructed *outside* major cities. Obviously, the Russians feel that since we concede them first strike, they will have time to evacuate target cities before retaliation arrives.

In the United States public apathy has been astonishing. This is partly the result of Administration policies designed to play down the horrors of nuclear war, and play up our own strength. One high former Civil Defense official who resigned in frustration and disgust said recently he was handicapped by a White House directive "to say nothing that will alarm the public."

If the public is not alarmed or aroused by the prospect of atomic holocaust, it will not bother to dig in or protect itself in any way. This lethargy has been encouraged by the budetary brushoff given Civil Defense. The annual DOD budget is about $41 billion, augmented by more billions for CIA, the Atomic Energy Commission, Security Service, and arms for our allies. Altogether, preparations for war, or to deter war, cost close to $50 billion annually. The annual budget of Civil Defense has been only about $60 million, or one-eighth of one percent of the total. If one objective of defense is

PRICE OF DEFENSE . . . How to Compute Shelter Cost



Military

to save the nation's people, this disparity makes our entire defense effort appear a gigantic boondoggle.

The public attitude of unalarm hides behind many masks. One, despite the most serious warnings of military leaders—and logic—is "Oh, they won't use H-bombs, just like they didn't use gas in the second World War." Another is fatalistic—an "On the Beach" attitude: "If everyone else is going to die, I don't want to survive."

We live on an unstable planet in a time of troubles, although in a world of unlimited hope for progress as well as unlimited danger. RAND, Rockefeller, Holifield Committee, Mershon, and other reports, indicate that 100,000,000 Americans would be killed instantly, or die within 60 days, should we be hit by surprise attack in our present unprepared state. This assumed a Russian first strike of 5,000 megatons delivered by rocket, submarine-based missiles, aircraft, and nuclear mines dropped in our harbors. This weight of death is within the Soviet capability. Even if we "won" such a war by obliterating Russia, we would lose it.

• **Another chance**—Realistic protection of civilians would cut deaths by 50% or more, most authorities agree. We could scramble back on the highway towards civilized progress within five years instead of a century—or never. A strike against this nation today might dump the survivors back into the Middle Ages.

The new Administration is in a position to do something about it.

When he replied to a MISSILES AND ROCKETS open letter, a reply published in the Oct. 10 M/R, Kennedy indicated the course he hoped the Symington Committee would take.

This included joint commands incorporating all three services and built on functional lines; i.e., a Strategic Command, a Mobile Strike Force (Tactical), a Defense Command, and certain area Commands. The Symington proposals closely follow the Kennedy thinking.

Members of the committee recalled the old schoolboy adage that if you are ready to dish it out (which this country is) you must also be ready to take it, which this country manifestly is not. Survival of our 180,000,000 citizens must be fashioned into a strong supporting beam of the national military posture. Obviously, an unprepared population invited attack.

• **The only way?**—So the inclusion of Civil Defense in a military command is under consideration. It would have its headquarters in the Pentagon and its civilian and military chiefs would report directly to top-level officials of the Administration.

Placing Civil Defense within the military establishment is the only logical means of providing it with a stable platform and basic support. In the event of nuclear attack on the United States, martial law would be declared instantly, so in a crisis civilian defense would be subordinated to the military in any case. Furthermore, in all-out war the National Guard and organized Reserve would be called into action within the Zone of the Interior at once. It was felt that the National Guard and the reserve should provide the chief components of the new U.S. Defense Command. It should be their primary mission, the secondary being

(Continued on Page 36)

THIS "DO-IT-YOURSELF" NOMOGRAPH provides a way to rapidly approximate the costs of various types of structures at overpressures from 0 to 200 psi. It was devised by Burns and Roe, Inc., New York consulting engineering firm.

The structures considered are (1) rectangular, above grade; (2) arch-mounded or partially buried; and (3) dome, fully buried.

The costs from the nomograph are for excavation, structure, lighting and ventilation for a minimum type facility only. For more complex facilities, a first approximation of additional costs for architectural, mechanical and electrical items may be obtained from Table 1.

Nuclear physicist Dr. Ralph E. Lapp, consultant to the Joint Congressional Committee on Atomic Energy, presented the overpressure data in Table 2 during recent Congressional hearings on civil defense.

The derived costs can be used only as a general guide. Variables such as site location, soil type, water table depth, area of structure, and complexity of facility have marked influences.

• **How to use nomograph**—Scale (1) lists overpressures and scales (2), (3) and (4) list costs per square foot for rectangular, arch, and dome structures, respectively. Scale (14) can be used for any overpressure for the specified span for each type of structure. Scales (5) through (13) are used for variations in the span and are applicable only for the overpressures noted at the top of the scales.

Example 1: What is the cost per sq. ft. for a 28-ft. span arch Administrative type facility at 30 psi?

(a) Draw a line from 30 psi on scale (1) to Arch on scale (14).

(b) Read $16.7 per sq. ft. on scale (3).

(c) From Table 1 for Arch-Mounded, Administration Building—Additional cost: $11 per sq. ft.

(b) Answer—steps (b) + (c) = $27.70 per sq. ft.

Example 2: What is the cost per sq. ft. for a 35-ft. span arch minimum facility at 100 psi?

(a) Draw a line from 100 psi on scale (1) to 35-ft. span (100 psi) on scale (9).

(b) Answer—read $34.80 per sq. ft. on scale (3).

TABLE 1—Additional Costs Per Sq. Ft. For Architectural, Mechanical and Electrical Items

Item	Facility Type	Rectangular, Above Grade ($/sq. ft.)	Arch-Mounded ($/sq. ft.)	Dome, Buried ($/sq. ft.)
ARCHITECTURAL	Admin. bldg.	6	4	6
Partitions, finishes, hung ceilings, etc.	Electronic facility	7	5	7
MECHANICAL	Admin. bldg.	5	5	10
H & V, air conditioning, plumbing, air filtration, etc.	Electronic facility	8	8	16
ELECTRICAL	Admin. bldg.	2	2	4
Lighting, outlets, power connections, etc.	Electronic facility	5	5	10
TOTAL	Admin. bldg.	13	11	20
	Electronic facility	20	18	33

The costs not included: site improvements, entrance structures and blast doors, water supply and sanitary facilities, ventilation shafts, standby power, electronic equipment cooling.

In general, these items increase in cost progressively—from Above Grade, to Mounded, to Buried—and increase with increasing design overpressure. Entrance Structures may represent a substantial percentage of total cost for small or deeply buried structures.

TABLE 2—Blast Overpressures Produced by Explosion of a 10-Megaton Bomb

DISTANCE (miles)	1.0	1.4	1.9	2.8	4.1	6.1	9.7
OVERPRESSURE (psi)	200	100	50	20	10	5	2.5

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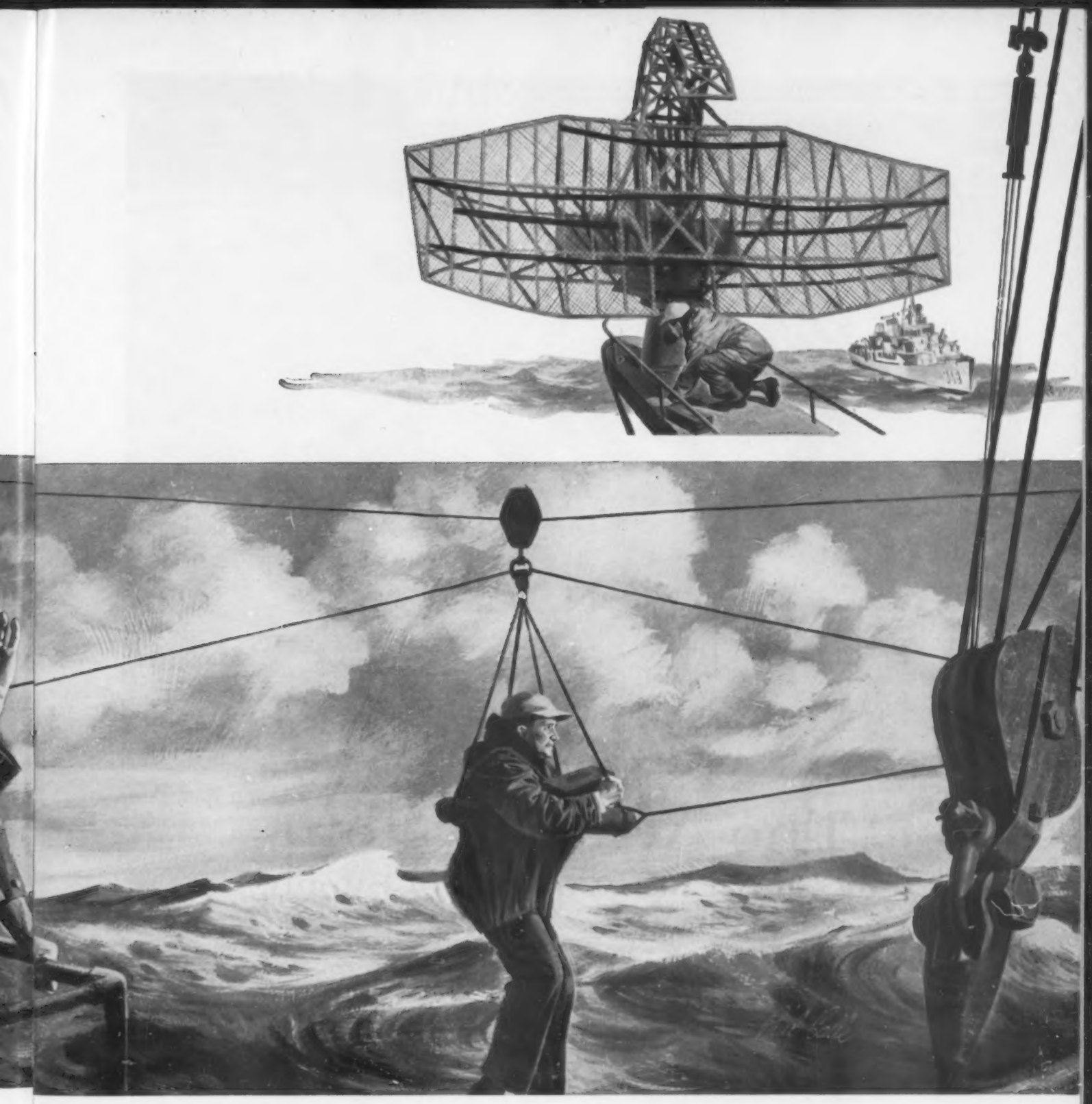

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Technical Countdown

ELECTRONICS

IR Power Supply Minified

A power supply the size of a flashlight battery developed by Victory Electronics, Inc., for infrared use produces a 16-kv (open circuit), 0.1-microamp output. Even under a load up to 0.5 microamp, voltage change is not more than 800 v, says the company. Both Army and Navy are now testing the unit.

Missile Bloom Effect Measured

Radiation associated with the whitish glow which develops around a missile during nocturnal firings is being measured by Radiation, Inc., at the Missile Test Center, Patrick AFB, Fla. Known as "missile bloom effect," it appears at an altitude of 120 km, has a diameter of several kilometers and persists for many seconds. RI is using its RSVP (radiation spectral-visual photometer) and a 35-mm cine camera for observations which are part of current Interservice Radiation Measuring Program.

EIA Forms Electronics Procurement Committee

Establishment of a new committee to handle Electronics materials management problems has been approved by the Electronics Industry Association. The group, headed by H. A. Strickler of Martin, is composed of procurement and materials directors of EIA member-companies.

Laser Improvement Reduces Power

Raytheon has developed a light-pump reflector which can reduce power required for ruby laser action by about 90%. The new device may aid in development of a sought-after continuous-wave laser.

SUPPORT EQUIPMENT

Azusa Mark II in Use

Convair's improved *Mark II* Azusa missile tracking system has been put into operation at Atlantic Missile range. The $10-million tracking and impact-prediction system also can be used to track space vehicles in orbit and calculate satellite rendezvous and interception points in space.

New Radar Quantizer for Pershing

A new radar quantizer, to be used in 3-D tracking of *Pershing* missiles, is reported capable of providing a position plot resolution of ±2.5 feet. It will be used with a digital computer to provide monitoring engineers with instantaneous position data on the missile test flights. The device is built by Computer Equipment Corp.

Wire and Cable Problems Unresolved

The Department of Commerce hasn't given up the idea, but plans to survey the missile wire and cable situation and help bring some order to the current chaos have been shelved for the present. Big problem is that procurement is handled almost entirely by industry and there is no one body empowered to set specs, requirements, and definitions. (M/R will publish an article in the near future on the prevailing conditions and what needs to be done.)

PROPULSION

Cluster of F-1's Proposed

A two-engine cluster of Rocketdyne F-1's has been proposed by Marshall Space Flight Center. The resulting 3-megapound-thrust booster could be built for use as a flying test bed by 1964—if funds were made available now. Development of F-1—taken over by Marshall last month—is on schedule. Preflight rating tests are planned to begin in late 1962 and be completed by early 1963.

Cracked LOX Dome Plagues Saturn Test

Premature cutoff of the Dec. 2 *Saturn* static test after two seconds was apparently due to a cracked LOX dome. No resulting damage was reported.

Underwater Missile Propulsion Advanced

Compact 20-HP engine developed by Avien, Inc., is believed capable of greatly increasing underwater missile payloads and extending operational depths and operating life. The 17.3-lb. unit offers very low fuel consumption, low rpm, and a minimum number of moving parts, says Avien.

MATERIALS

Madison Ave. Next into Space?

Space writing in orange letters against the evening sky, visible for hundreds of miles, is now a real possibility. According to Lockheed MSVD scientists, the idea is an offshoot of a method of tracking re-entry vehicles by releasing a stream of sodium. The trail would be stable for about 30 minutes; precise measurements would show the exact angle of descent. A similar trail of cesium would be radar-reflective under cloudy conditions, they said.

Steel Casting License Granted

The Parlanti Mould Process of steel casting will be used by the Swedish Crucible Steel Co., Detroit, under license from General Communication Co. The process results in castings with superior mechanical properties through the ability of the moulds to rapidly conduct heat away from the cast mass of metal.

Mo & Nb Alloys Tested for Re-entry

Vehicle re-entry tests will be undertaken at Wright Air Development Division to check out new combinations of molybdenum and columbium alloys. A typical glide re-entry vehicle to be constructed by the Air Force and engineers from General Electric and McDonnell will be put through simulated re-entry.

Toolless Metal Removal Perfected

A new process, developed by Steel Improvement and Forge Co., has no metal-to-metal contact and no tool wear. A part to be machined and electrodes made in the size and shape to be duplicated are placed in a chamber while a rapidly flowing chemical solution carries an electric current from workpiece to electrodes. Rate of metal removal is governed by the amount of electric current applied which varies with the metal type.

Plastic "Starch" to Stiffen Echo

One possible solution to stiffening the next *Echo* balloon satellite (so its reflected signals won't be distorted) is using a soft plastic that can be folded into the satellite but will polymerize into a harder substance by action of strong sunlight.

Russian Glass Reacts to Sunlight

The Russians have developed a glass that turns opaque when exposed to strong sunlight. The milky-white appearance diminishes with solar intensity and the glass becomes transparent again.

INSTANT FLIGHT

Varied stresses of programmed flight will soon be duplicated at ground-level. A $10 million static test facility, designed by Vitro for the U.S. Air Force, will shortly begin operations at Wright-Patterson. Here, major components will be subjected to programmed aero-dynamic heating and dynamic loading of supersonic flight. ■ In eleven major Vitro projects, the precise simulation of unusual environment was vital; twenty-one Vitro projects required design of nuclear containment. This is Vitro know-how.

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MPI's 'Hi Mod' Glass Fiber

Material opens new concept of motor cases

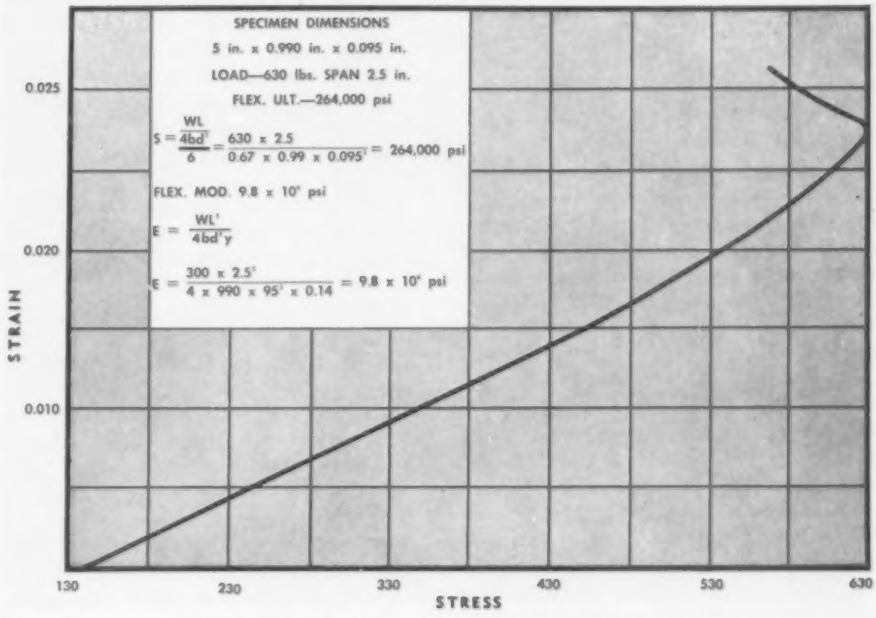
by John Judge

THE REMARKABLE PROPERTIES of a new glass fiber material are generating a considerable amount of interest in the missile frame industry.

The material is the result of a process conceived by J. F. Brossy, vice president of Materials and Processes, Inc. B. F. Goodrich is producing the material for its own use under a licensing-consulting agreement entered into with MPI in June, 1959 (M/R, Nov. 28, 1960, p. 28). Negotiations are underway with a British firm for a similar license.

Designated "Hi Mod," the substance actually retains more of the basic strength of the glass fiber and lowers the resin content of the laminate.

"Hi Mod" is a parallel glass fiber tape drawn from a chemically stable glass and impregnated with a resin microseconds after forming. It was originally developed under a Navy Bureau of Ordnance contract.



HOW "HI MOD" performs under increasing stress and strain.

• **Wide Resin Range**—The laminate's adaptability permits the design engineer to tailor it to suit his particular purpose. The production method allows the use of almost any resin capable of being B-staged. A variety of resin systems including epoxies, modified epoxies, phenolics, high temperature phenolics, silicones, DAP's and triallyl cyanurates have been successfully applied. Resin content has been as low as 9% and rarely goes over 25% by weight.

According to Brossy, the high modulus of "Hi Mod" assumes greater importance as rocket motor cases increase in size. An entirely new concept in case construction is being explored involving a barrel stave configuration in which the unidirectional Hi Mod fibers can best be used in larger vehicles.

In the complex business of producing laminates, it has long been known that most structural degradation originates at the interface between the resin matrix and the fiber reinforcement. The bond strength is destroyed through capillary action aided by a molecular layer of water on the fiber surface.

• **Weakened fibers**—Another item is that relatively little of the inherent strength of the glass fiber has ever been translated into a glass plastic laminate. Since a fiber of 8 to 10 microns is almost all surface, it is highly notch sensitive. The commercial practice of twisting fibers into yarns, abrading, lubricating, heat cleaning and weaving them removes a major percentage of this inherent strength.

In addition, the fiber in its nascent state is extraordinarily reactive—readily attracting any substance present in the atmosphere to its surface. This reactivity has given rise to some bizarre effects. In one case it was thought that heavy welding being performed some distance from the fiber extruder was the cause of the otherwise inexplicable presence of iron in the fibers.

It is for this reason that each individual fiber is encapsulated in resin immediately upon leaving the furnace orifice. This matrix resin protects each fiber from abrasion and preserves a major percentage of the available strength.

Brossy feels that it is possible that the polar groups in the resin tend to react with the hydroxyl groupings on the fiber surface before atmospheric elements are attracted.

• **Side by side effects**—This parallel drawing and encapsulation permits true orientation of the fibers as well as a higher glass content. It is generally accepted that glass fibers have little or no elasticity and progressive failure occurs in laminates where some of the reinforcement is kinked or twisted. The parallel orientation reduces this effect. The material can be handled without the usual danger of damage.

Brossy says that a laminate system having a greater number of fibers unharmed by abrasion or contaminates should have superior physical characteristics under load—including moduli.

This is in opposition to the general notion that modulus is not affected by handling or damage to the fiber strength by abrasion.

Successive plies of this oriented mat

Hi Mod Optimum Test Data Uni-directional Flat Laminates

Flexural Ultimate	274,000 psi
Tensile Ultimate	250,000 psi
Flexural Modulus	10.4 million psi
Wet Strength Retention*	96.5%
Specific Gravity	2.1—2.2

*After standard 2-hour boil test

tend to nest together, drastically reducing chances of interlaminary shear.

A greater degree of homogeneity is achieved because of the narrow fiber diameters used instead of threads consisting of 200 fibers or more. Overlapping is minimized and a uniform distribution of resin and reinforcement is attained.

At least one manufacturer has produced a pressure vessel using "Hi Mod" with integrally wound closures having a strength/density ratio in excess of 3 million inch-pounds per pound. This corresponds to a unidirectional stress of 340,000 psi with overall hoop stress above 225,000 psi and accompanying moduli between 9 and 10 million psi. In hydrostatic tests, no moisture vapor barrier or liner material is needed.

• **Honey combed Hi Mod**—The material has also been used successfully for structural reinforcement members. In laboratory experiments, sandwich panels have been fabricated by cross laminating two plies of "Hi Mod" on either side of 1/8 in. cell aluminum honeycomb.

No adhesives were used. The assembly was pressed at 50 psi and cured. Tests to get tension failure in the lower panel were futile—breaks being always in compression. When 4-point loading, span extension and flat plates against the panel were tried, failure occurred —in the core.

Tensile stress on the lower skin was calculated at 285,000 psi. Peel tests resulted in the core tearing.

According to MPI, the characteristics of glass fiber play an important part in the physical properties of the laminate—but only a part. There is a combination of elements that contribute to a successful end product. Such things as the resin and actual winding techniques are also of prime importance.

But the profound effect of stringent quality control measures are such that this control is imperative. In Brossy's opinion, reproducibility can be assured in no other way. MPI is incorporating intensive quality control procedures in their new production equipment.

The firm expects to be shipping Hi Mod in production quantity sometime in April, 1961.

Although MPI is in the position of a materials supplier and not a fabricator, they have a great deal of interest in production. The unusual qualities of their laminates can be nullified through improper fabrication methods. Hi Mod tapes have been used with existing filament winding equipment but it is believed that truly optimum results will require the development of winding techniques better suited to a parallel fiber tape. Such equipment has been designed and is now in use by one of the major motor case fabricators. ⌗

Home Grown Quartz Signals End of Dependence on Imports

Hydrothermal Process at Western Electric produces tailored crystals for communications devices economically

NORTH ANDOVER, MASS.—The U.S. will soon become self-sufficient in one more critical material with the advent of a quartz crystal production facility at Western Electric's Merrimack Valley Works.

Quartz crystals are instrumental in the regulation of radio frequencies and as a source of ultrasonic waves. The material is usually imported from Brazil and certain areas in Madagascar.

The pure, colorless natural crystals required for communications average about $30 a pound in cost. But the presence of imperfections and the waste resulting from the cutting and slicing operations can run the price tag of the final plates up to $1500 per pound!

The growing process was developed at Bell Telephone Laboratories and commercial methods were designed in conjunction with Merrimack engineers.

The hydrothermal process is essentially the dissolving of natural or artificial nutrient quartz crystals in a basic solution and then their redeposition on shaped "seed" plates.

For this purpose, a series of autoclaves were designed and installed at the Merrimack plant. Automatic controls maintain a precise temperature differential between the nutrient (lower) zone and the growing (upper) zone in each autoclave.

Temperatures approaching 700°F and pressures up to 25,000 psi are necessary for the successful formation of crystals. A particularly knotty problem was the design of a repetitive closure for the units.

•**Three-week incubation**—The growing cycle lasts about 21 days, during which time the autoclave is completely under automatic controls. Only three men are required to operate the entire growing area. The vessels are expected to last 10 years before replacement is necessary. For this reason a chromium-molybdenum steel was chosen, as the autoclave material, since the nutrient solution is highly corrosive at the required temperatures and pressures.

The synthetic crystals have a number of advantages over their natural brothers. Besides offering the obvious merits of availability and size, the material can be grown in configurations that permit the most efficient sawing and shaping operations.

The grown crystals have none of the impurities often found in even the best natural stock and can be produced without either optical or electrical twinning.

End product yield of the artificial quartz is estimated to be about 2.5 times that of the natural crystals. Western Electric officials indicate that the growing facility will ultimately provide 90% of the Bell System's crystal needs. The nutrient crystals used as the starting product or small, inexpensive pieces of natural quartz, readily available from many sources but totally unsuitable for communications purposes.

Some research has been performed on other starting materials, such as certain types of sand. But Western Electric feels there is no real need for alternative raw materials since the current one is in abundant supply.

The process is being licensed by some firms both here and abroad. The development will prevent the occurrence of a critical shortage of quartz during national emergencies. In addition, the reduced cost of the artificial crystals may prompt their use in wider applications as substitutes for other elements in electronic circuits. ⌗

SYNTHETIC QUARTZ CRYSTALS emerge from an autoclave three weeks after the seed crystals were sealed within the vessel.

Evaluator May Be Used for Saturn

Packard Bell's SE-1000 is relatively simple, highly reliable and easily adapted to new requirements

THE NEXT MAJOR SERIES of static tests of the *Saturn* may use Packard Bell Electronics' new SE-1000 Systems Evaluator. Contract negotiations for the computer-controlled automatic checkout system are now being conducted at the Marshall Space Flight Center.

Packard Bell claims that the SE-1000 is less complex and more reliable than an equivalent programer-comparator.

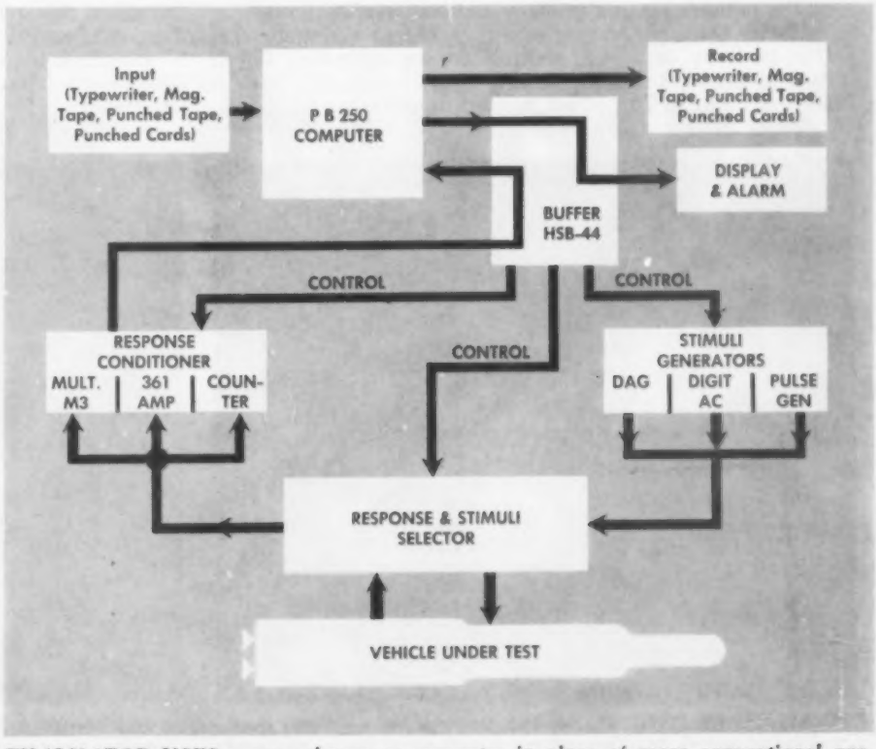
It is sufficiently flexible, the company reports, to handle any number of different missile systems, ranging from large multiple-engine liquid boosters to small solid-propellant units.

The system was demonstrated last week at the American Rocket Society meeting in Washington. Among the observers were Navy engineers who could be considering the SE-1000 for use with *Polaris*. Packard Bell built factory checkout equipment for *Polaris* and used many of its developments in SE-1000.

The system has several advantages. Probably its best feature is that it is made up of off-the-shelf components, including the pb250 computer, the heart of the system. This solid-state general-purpose computer has been available for some time as a commercial unit.

Another big advantage is the versatility, or flexibility, of the system. Packard Bell claims that computer control allows changes to meet the requirement of different systems, new instrumentation, or changed programs with little or no change in hardware design. It can incorporate manual control inputs in parallel with computer control with no modification. A further claim is that the SE-1000 is easily adaptable to factory, depot, or line checkout requirements as well as to component, subsystem, and total system level. ⌘

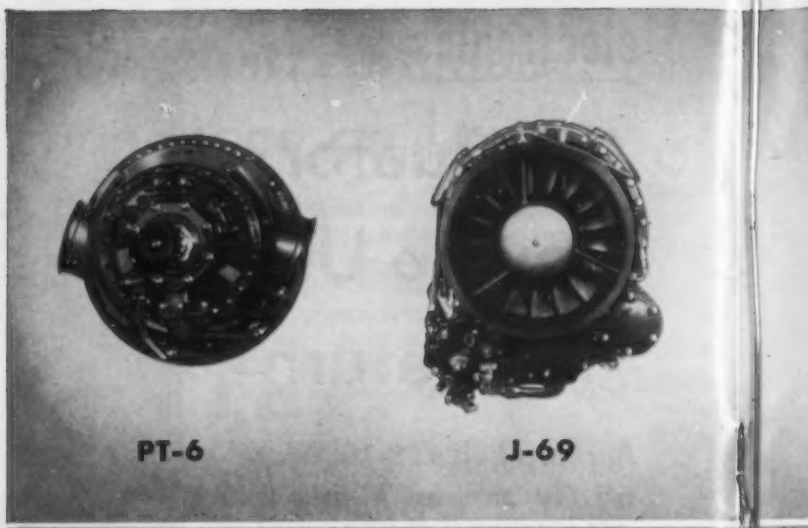
SE-1000 PROTOTYPE is used in demonstration of system performance. A "space vehicle simulator" in the console serves as the unit under test.

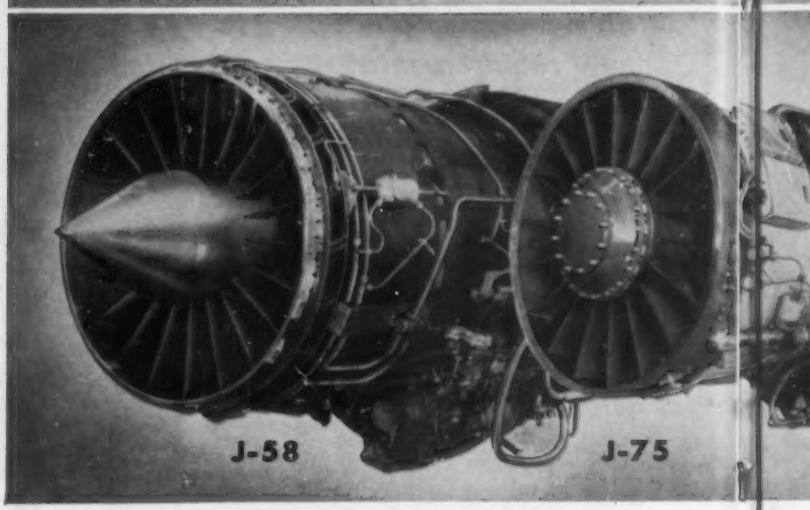


EVALUATOR USES a general-purpose computer in place of more conventional programer-comparator units. Other system components are basically the same.

Controls for the "hot ones"

- for over 23,000 aircraft gas turbines
- for a liquid hydrogen rocket engine
- for the B-70's air-induction system
- for the power forms of tomorrow

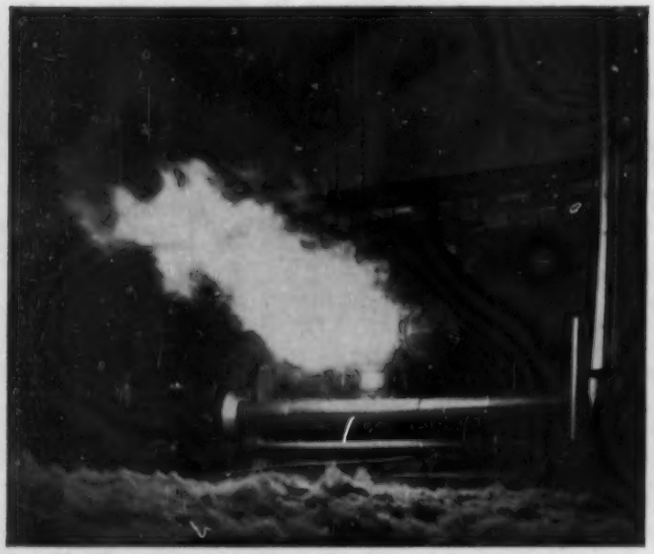




Hamilton Standard has supplied fuel and engine controls for over 23,000 aircraft gas turbines—powering 17 types of the nation's leading military and commercial aircraft.

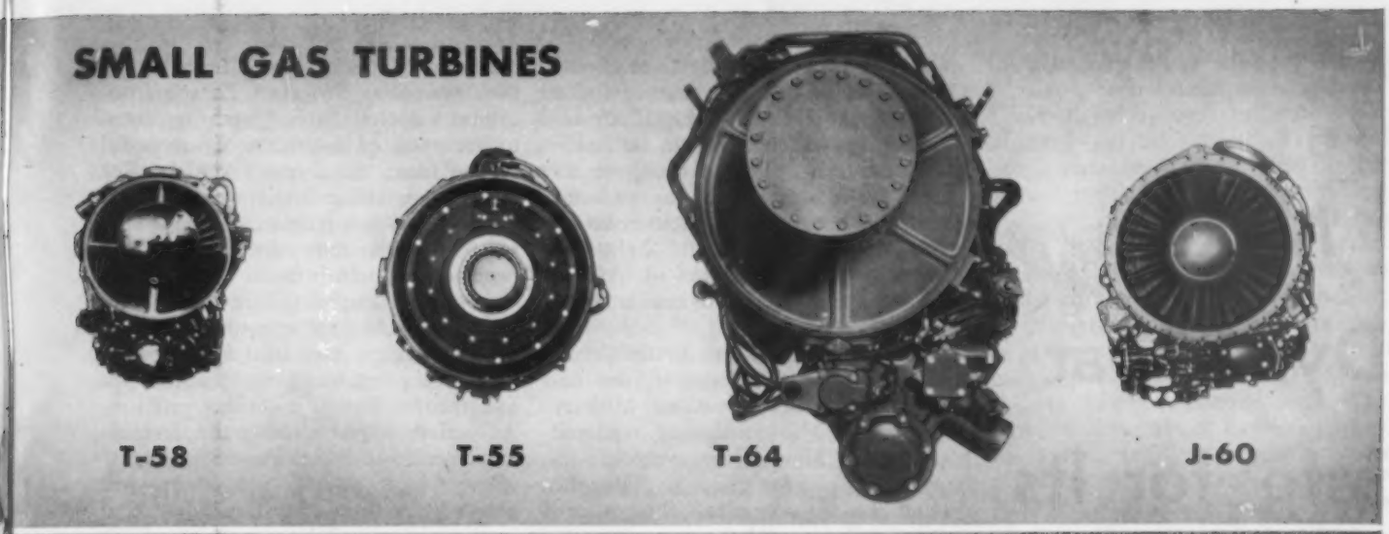
Today, its experience is being applied to a new generation of "HOT ONES" . . . controls for an advanced liquid hydrogen rocket engine . . . a unique air-induction system for the USAF B-70 . . . hot gas servos and other hydraulic, pneumatic and mechanical devices for missiles and space vehicles. And for the power forms of tomorrow, Hamilton Standard research is furnishing new ideas for control of ion engines, fuel cells, ramjets and industrial gas turbines.

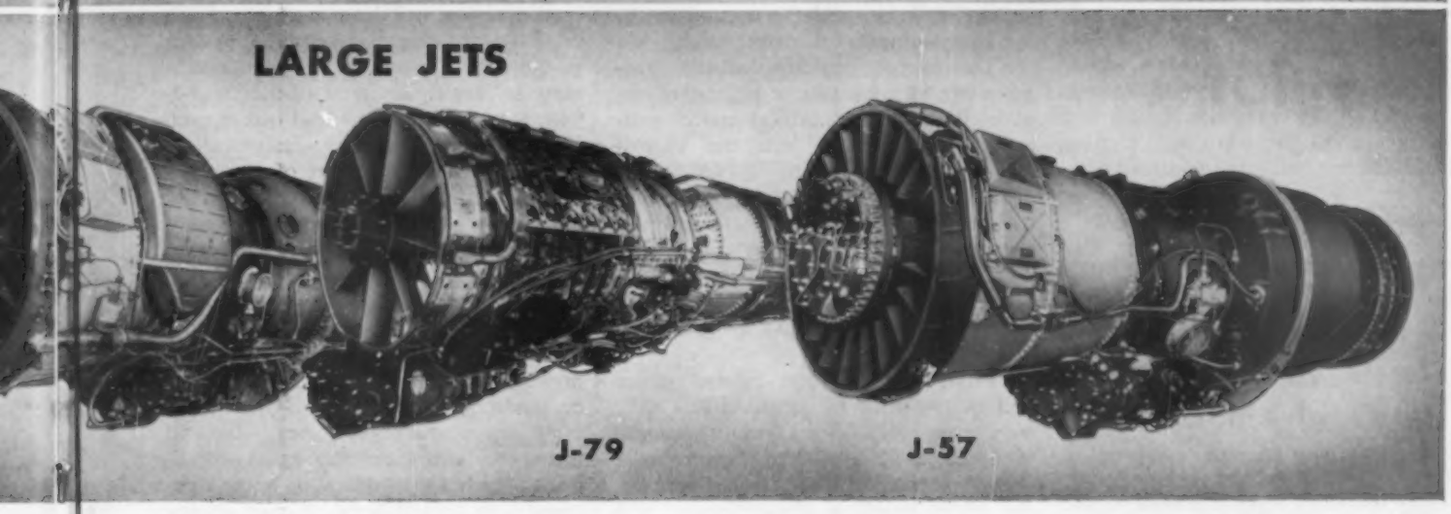
Hamilton Standard has the ability to solve your control problems—from concept to completion. Your inquiry is invited.



ROCKET ENGINE CONTROLS. Hamilton Standard has developed thrust modulation controls and fuel-oxidizer shut-off valves for an advanced liquid hydrogen engine. This work has provided important breakthroughs in low-temperature sealing problems and system reliability.

B-70'S AIR-INDUCTION CONTROL SYSTEM, now under development at Hamilton Standard, involves some of the most advanced control problems ever encountered. It is designed to provide the most efficient air-flow into the plane's engines over an unusual range of operating conditions.





HAMILTON STANDARD

HAMILTON STANDARD

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ENVIRONMENTAL CONDITIONING SYSTEMS for space vehicles and such advanced aircraft as the B-58, 880, B-70 are important aspects of Hamilton Standard diversification.

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Making Dyna-Soar 'Safe' for Its Pilot

A report on the Air Force's unprecedented effort to give maximum protection to its space travelers; why 'safety' and 'reliability' aren't always synonymous

by Everett J. Hodapp, Jr.

Mr. Hodapp is Dyna-Soar Engineering Officer, Wright Air Development Division, Wright-Patterson AFB, Ohio. This article is reprinted from the December, 1960, issue of AEROSPACE SAFETY, published by the Office of the Deputy Inspector General for Safety, USAF, Norton AFB, Calif.

WITH THE DAWNING of a new age in aviation history—manned space exploration—it is essential that an active, vigorous safety program be established for each of the many space research projects scheduled or contemplated. The hazards involved in boosting a vehicle into space, orbital flight and re-entry make it necessary to redirect the safety efforts applied to conventional aircraft.

Of immediate concern to the Wright Air Development Division is the development of the *Dyna-Soar* Military Test System. This consists of a piloted hypersonic boost-glide vehicle, a booster to place the glider in flight, the ground launch complex, the ground support systems, and the ground tracking and communications facilities.

The overall objectives of the program are to demonstrate piloted boost-glide flight up to orbital speed with hypersonic re-entry into the atmosphere and maneuvering to land at a preselected conventional air base, and to lay the groundwork for the military systems which will exploit these technical advances. This is to be accomplished by a flight test program at two sites. It will encompass two distinct phases.

First, the full-scale piloted glider will be tested at Edwards AFB, Calif., by a series of drop tests from a specially modified B-52 aircraft. Performance will be limited in these tests. However, the glider handling characteristics will be evaluated as well as basic subsystems performance.

This test phase will be followed by a series of ground-launched unmanned and manned flights from Cape Canaveral on the Atlantic Missile Range. These tests will show how the glider responds in the hypersonic flight regime to the maximum-velocity capability of the booster.

After these sub-orbital flights are successfully completed, the same glider thus far developed in the program will be boosted from Cape Canaveral to velocities which will enable it to circle the earth and land at Edwards AFB.

It is readily apparent that the *Dyna-Soar* safety program must cover many aspects. At this stage of the program, primary emphasis is being placed on formulating a system design which minimizes the possibility of fire, explosion, release of toxic vapors, and inadvertent or abnormal component actuation. Such hazard-preventing activities are applied to all manned vehicles. But, a greater emphasis has been placed on the manned space vehicles for these reasons:

- Pilot survival has been stressed and programs to insure man's safe return have been given high priority in both the NASA Project *Mercury* and the *Dyna-Soar* Program. Escape from orbital vehicles has not been perfected to the point of assurance of successful escape from the primary vehicle. For this reason the primary vehicle must be designed for maximum operational safety—which may necessitate compromises in performance.
- A catastrophic failure at any point in the mission profile could cause the pilot to escape and land in a remote land area or at sea. How to search for and recover him is a serious problem. An active program during the development period to design and install highly efficient and reliable subsystems will markedly reduce the likelihood that escape action will be necessary.
- To develop the required system in the time allotted, it has been necessary to anticipate state-of-the-art advances within this time and utilize such breakthroughs in many design areas. This is justifiable in light of the existing competition between world powers, but such a procedure limits the amount of testing which can be conducted prior to integration into the production article. For this reason, design safety analyses are an important part of the development cycle. Modification to improve overall safety and reliability must be made early.
- There are many "grey" areas in trying to anticipate the exact conditions which the space vehicle will encounter in orbital flight. A part of any effective safety program is to analyze the expected hazards through a careful review of existing data obtained from exploratory NASA and military programs such as the *X-15* and *Discoverer*. From this information, certain potential hazards can be appraised and appropriate safety precautions taken.

To present a detailed account of the *Dyna-Soar* Safety Program at this time is not possible; the program is new and there are design changes every day. A fundamental operational concept, however, has been formulated by the Fire Protection and Safety Section of the *Dyna-Soar* Engineering Office—as have the requirements for basic protection devices.

The primary objective is, of course, to provide a military test system capable of exploring the hypersonic and orbital flight regime which will assure the ultimate in pilot safety. A continuous coordination effort is being accomplished within the *Dyna-Soar* System Project Office to insure that final design approaches give adequate consideration to safety implications.

The same approach is being followed by the Boeing Airplane Company, prime contractor on the *Dyna-Soar* program, its subcontractors and

the USAF associate contractors. The mechanics of the safety programs involve safety and reliability groups at management level. Boeing has established a Fire Protection and Safety Office to maintain surveillance of fire and safety aspects of the overall *Dyna-Soar* System. This function is complemented by individual safety engineers at a design level for each major element of the system. These elements include glider, booster, launch complex, and support equipment. In many cases the reliability and safety efforts of subcontractors have been placed in one common group.

While reliability and safety are closely related, there are unique differences in how they are dealt with in the early stages of system development. In the selection of the best subsystem design approach, safety is influenced by the mode of operation, materials utilized, and packaging concepts.

As an example, consider the selection of an electrical power system for a short-flight-time glide vehicle. A battery could be designed to accomplish the desired function. Another alternative would be the use of a chemically fueled power-generating device. Through design efforts and use of redundancy the two approaches could be given similar operational reliabilities.

From a pure safety viewpoint, however, the battery is free of the hazard potentials of fire and high-speed rotating equipment. Relative system weights may make it prohibitive to use batteries, but it is obvious that they offer certain safety benefits.

Although operational reliability and safety are similar in nature, using the terms synonymously may lead to an oversight in the space system development phase which could create problems when the system becomes operational. This is especially true when there is a market variance in the degree and nature of ground support for the subsystem approaches. Servicing a subsystem with hypergolic fuels and oxidizers present many safety problems not encountered in servicing with conventional fuels and ozidizers such as RP-1 and LOX.

Safety information published and operating procedures established by the Ballistic Missile Division contractors on the ballistic missile programs, and the basic research conducted by the Directorate of Advanced System Technology at WADD, complement safety approaches enforced during development of aircraft systems. Programs analyzing the hazards associated with the use of hydrogen have been completed, work is now being conducted to evaluate methods of surpressing fires involving propellants proposed for our space research programs. The safety procedures enforced in such programs as *Titan* have been very effective. Such procedures can to a large extent be applied to the launch site safety efforts necessary for the *Dyna-Soar* ground-launched flights.

These design safety approaches for the *Dyna-Soar* glider have not as yet been finalized, but the following programs are being developed to improve overall system safety:

• A materials selection program will analyze all materials scheduled for incorporation into the glider. The analysis will consist of determining the thermal decomposition characteristics of each material used and determining the relative safety from the viewpoint both of toxicity and of fire. Where materials show an unacceptable hazard potential, the program will look for a suitable replacement. NASA has pursued a similar program for the crew station on Project *Mercury*; it has changed, for reasons of crew safety, several materials proposed by the prime contractor.

BIG FLIGHT for Dyna-Soar will follow series of sub-orbital tests. Boost-glider will be piloted around globe from Cape Canaveral to Edwards AFB.

• In several areas of the *Dyna-Soar* glider there is a potential fire hazard, should propellant leakage occur during critical flight conditions when ignition may occur. Every effort is being made to incorporate passive safety measures to minimize such a possibility, but a means must be found to enable the pilot to visually inspect remote regions. It has been demonstrated that the temperature sensitive and surveillance detectors now available are not highly reliable.

Many difficulties of moisture, wiring and maintenance have been encountered in the detection system. It is unlikely that the pilot would have enough confidence in the system to initiate glider escape solely on the basis of a fire or overheat warning light.

A lightweight surveillance system utilizing optical fibers has recently been introduced to the fire detection system industry. It is composed of a fiber boundle consisting of glass fibers 0.002 in. in diameter. Each fiber can transmit light from the desired surveillance point to a viewing station.

If several thousand units are placed in a bundle, a picture can be transmitted from the hazard area of *Dyna-Soar* to the pilot's compartment. Where only the detection of flame is required, the system requires a simple type of fiber bundle construction. To obtain a picture quality image requires a bundle of more fibers which are oriented. Much remains to be learned about fiber bundle performance in different environments; but it is acknowledged that using such a system will make it possible for the pilot to visually appraise the hazard before he initiates corrective action.

When the fiber bundle is utilized with a conventional temperature or surveillance detector, the pilot will respond to the temperature indication by visually viewing the area of concern. The *Dyna-Soar* Engineering Office is also considering use of this lightweight surveillance system for checking the possible presence of fire, smoke, fluid leaks, or other hazards within remote parts of the system such as the booster and transition section.

In regions of the glider where a high probability of fire or explosion remains after all practical hazard prevention techniques have been incorporated, the use of explosion suppression systems is being considered. In general, these systems consist of a pressure or light sensitive detector which picks up the small pressure rises or light emission associated with the initiation of an explosion.

In milliseconds, the detector responds and automatically discharges chemical suppressants. The action inhibits the explosive reaction—and, in hydrocarbon and air explosions, prevents pressure rises from exceeding approximately 3 psi. This technique eliminates structural and component damage, whereas an uninhibited explosion, which could produce pressure rises in excess of 100 psi, would have caused a catastrophic failure. As the *Dyna-Soar* glider design is finalized, a parallel program is planned to evaluate the effectiveness of explosion suppression systems on the fuel-oxidizer and monopropellant reactions which can be anticipated. When analyses so indicate, suppression systems will be integrated into the design.

(Continued on page 42)

Will Soviets Orbit First Ion Engine?

Details of Russian rocket engine experiment leads U.S. experts to predict another Red victory unless we press our effort

by Frank G. McGuire

PASADENA, CALIF.—Russia may put an operating ion engine in space before the United States does, according to experts who have studied progress in the field.

High-quality work in ion propulsion has been described in a technical publication which spells out the characteristics of the Russian engine, the instrumentation used and the scientific approach followed.

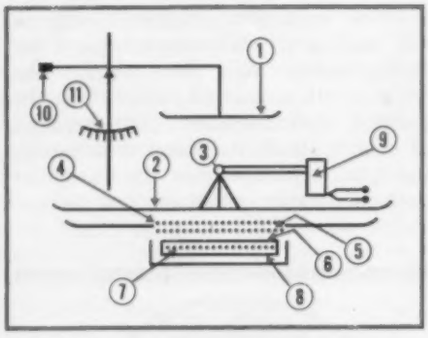
Dr. A. Theodore Forrester, head of the Ion Propulsion Laboratory at Electro-Optical Systems, Inc., evaluated the Soviet technical report of September, 1958, *An Experiment in Producing Reaction Thrust in a Laboratory Model of an Ion Engine*. He told M/R that the USSR appears to have been "at least on a par with American work of the same period, and ahead of ours in certain respects."

Continued Russian interest is evidenced by recent translation of a paper authored by Dr. Forrester and EOS scientist Dr. Robert Speiser which appeared in the Soviet publication *Astronautics and Rocket Dynamics*.

"Assuming that their effort since 1958 has been comparable to ours, and there is no reason to assume that it has not been, they are at least as close as we to placing an engine into space. I would say they are likely to do it sooner," he predicted, "based on the greater payload capability of their boosters, which would allow for more equipment, such as power supplies and instrumentation, in the vehicle."

• **U.S. has the horses**—If the U.S. put forth the effort, Dr. Forrester declared, it could put an ion engine into space first, because we do have reliable boosters for the task. EOS is developing a demonstration ion engine for the Air Force, and its space applications are rather obvious—although EOS will go no further than to state that the engine is being developed.

At the time of the Russian report, the Soviets were generating higher currents and more thrust than any United States laboratory at the time, and also had better instrumentation.



Soviet Experimental Ion Rocket Engine: Circa September 1958

1. Deflection plate for thrust measurement
2. Screen grid
3. Feed opening for cesium vapor
4. Grid for emitting electrons
5. Cutoff Grid
6. Surface for emitting ions
7. Emitter's Heater
8. Thermal Shields
9. Cesium Evaporator
10. Counterweight
11. Scale for reading thrust level

"The Russians were measuring thrust levels before we were," Dr. Forrester said.

• **Knowingly naive**—Not all of the Soviet picture is rosy, however. A "dead-end approach" was used, according to Dr. Forrester, in the Russian engine's feed system. In a practical system, he said, it is necessary to use a fine, porous-tungsten ionizer, with cesium being fed from the upstream side. Instead, the Russians sprayed cesium from above onto a hot tungsten plate and collected the resulting ions, accelerating them with electrodes. The thrust obtained by this method was about one millipound.

"Their approach was naive in many ways," Dr. Forrester pointed out, but they knew it. There was just too much natural cesium in the ion beam and the accelerating grid structure would very quickly wear away from ion bombardment."

Approaches paralleling the Soviets' have been followed in this country, Dr. Forrester said, but the approach most likely to lead to successful flight-type ion engines calls for using a porous tungsten ionizer, feeding cesium from the upstream side, and very carefully controlling ion focus to prevent ion bombardment and erosion of the electrodes.

• **Soviet engine details** — Surface ionization in the Russian experimental engine took place on a tungsten plate having an area of 70 cm^2 and heated to about 900°C by a tungsten emitter. The emitter's potential in respect to the ground was +3 kv.

The grids were placed 10 to 15 millimeters apart above the emitter's surface. An outside grid was used for emission of electrons, compensating the ion flux. The grid was of tantalum wire 0.2 mm in diameter, heated to 1700°C, with zero potential.

An additional grid with a potential of –0.5 kv was used to prevent reverse current flow. This grid was made of tungsten wire 0.3 mm in diameter, heated by electric current to a temperature which excluded the adhesion of cesium, therefore providing for a minimum emission of electrons from the grid.

Metallic cesium was evaporated in a special heater at 200°C. The atomic cesium beam was then let out through an opening in the feed tube and fed onto the emitting surface.

Temperature of individual elements in the system was controlled by thermocouples, an optical pyrometer and electric wire resistors. The selected resistances corresponded to the exhaust velocities of cesium ions, amounting to 70 km/sec.

A mobile system incorporating a nickel plate and located in the path of the beam at 10 centimeters from the engine was used to measure thrust. The force acting on the plate was measured on the basis of the plate's deflection from the equilibrium position. Both the mobile system and the cesium feed system were shielded against the dissipated fields by a nickel shield and by a grid.

The engine was placed in a vacuum chamber equipped with electrical leads and inspection windows. Pressure relief of about 10^{-5} mm of mercury was maintained in the vacuum chamber. During the loading of the metallic cesium, the installation could be placed

inside a protective argon envelope.

The deflection of the plate in the thrust measuring system was observed during accelerated voltage feed to the emitter under a heated condition of the cesium evaporator. The ion current had a magnitude of 70 milliamps in the emitter circuit.

Measured thrust was 0.5 ±0.1 g. Under these conditions, the Soviets said, the rated thrust value was 0.66 g.

There was considerable parasitic losses of neutral cesium atoms in the engine system, the experimeters reported, because a part of the atomic cesium beam bypassed the emitter surface. "These losses can be decreased," they said, "by using other systems of feeding the cesium atoms to the emitter surface, such as feeding through a porous emitter, mobile emitters with divided cesium adhesion zones and ion emissions, etc."

The paper indicates that the researchers were aware of the other criticisms of their system and planned to correct its faults.

• **Remaining problems** — Most of the problems which faced the Soviet workers in 1958 also faced other research teams, but most of these have been licked. EOS, for example, feels that it has enough experience to design a flyable ion engine right now.

The company is attacking the problems that remain. It is studying ways of preventing the scattering of cesium ions by neutral cesium vapor, choosing materials which will stand up under ion bombardment and decreasing the beam interception.

A space test of the ion engine design is necessary because of the significant difference between the walls of a vacuum chamber in a ground test and the infinite boundary of the space environment.

Dr. Forrester strongly advocates carrying out such a test as soon as possible—"even if it is on a scale too small for use of the engine as a prime propulsion unit."

Eventually, fully developed ion engines will have a major impact on space missions. Dr. Forrester pointed out that "adaptations of this type of propulsion for long-range trips to Venus and Mars and for hauling heavy payloads are but two of the obvious uses."

"A wide variety of applications also exist for near-space vehicles involving orientation, homing, guidance, control and vectoring controls for periods of time on the order of years. These factors make ion propulsion a field demanding intensive endeavor," he declared. "With these applications foremost in mind, every possible effort should be exerted to be first in space with ion engines." ⁂

Rocket Fuels Surpass Alloy State-of-Art; Research Program Underway

Recognizing that the new higher energy solid propellants required by the nation's missile and space programs cannot be used without definite advances in present motor materials, Grand Central Rocket Co. is placing substantial emphasis on a materials research effort. This effort is a significant portion of a $1,750,000 company-sponsored research program and it will explore fabrication techniques as well as new materials.

It is anticipated that in the period through 1970, motor cases will have to withstand substantial internal pressures and high temperatures within ever lower weight allowances and with increasing reliability. Thrust vectoring systems and nozzles also will operate under more extreme environmental conditions with flame temperatures as high as 7300°F and greater tendencies toward erosion. Promising materials for this type of operation appear to be an alloy of high melting point metal carbides, which can withstand temperatures of more than 7000°F.

Another most important area for investigation is that of design and fabrication techniques which will allow the use of very large, multi-million pound-second solid boosters as well as long duration high mass ratio solid motors for space applications. As the available energy of solid propellants becomes greater, the design and fabrication problems of such motors become critical with lightweight joints and minimum insulation assuming great importance relative to effective overall motor performance.

Appreciation of these and corollary inert parts problems has led Grand Central Rocket Co. to include materials and fabrication techniques in its broad program of rocket motor research aimed at development of the highest performance, greatest reliability and lowest cost rocket propulsion systems attainable.

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LUNAR PROBE

The moon — lacking an erosive atmosphere — may hold the key to the history of the solar system. Because of this lack of atmosphere, oceans, and wind, lunar explorations may help solve fundamental, universal questions.

Logically, the moon will be the first objective in the exploration of space. Initially the moon itself will be photographed and instrumented; then manned observation stations will be established for astronomical and meteorological purposes. In time, the moon will serve as an intermediate station enroute to other planets — step by step into infinite space.

The National Aeronautics and Space Administration's Lunar Program will utilize Lockheed's AGENA B satellite to play a significant part in forthcoming lunar explorations — as well as a host of other scientific space missions. The NASA lunar launch in 1961-62 will utilize the highly reliable Lockheed AGENA as second stage to carry the RANGER spacecraft. The AGENA will provide the extremely critical guidance and controls necessary to place the RANGER on the required lunar impact trajectory.

The lunar probe application demonstrates the versatility, reliability and success of the AGENA vehicle in Lockheed's satellite and spacecraft programs. Developed for the Air Force for use in the DISCOVERER program, the AGENA is utilized in the MIDAS missile defense alarm system and the SAMOS surveillance satellite system. Noted for a record of outstanding accomplishments, the AGENA is credited with being the first to be placed on a polar orbit; first to achieve a precise, predicted and nearly circular orbit; first to attain attitude control on orbit; first to eject a reentry capsule which was successfully recovered. The AGENA can be modified for a variety of space missions such as navigation, geophysical investigations, long-range communications and deep space probes.

Lockheed's capability in satellites and spacecraft, manifested by such an achievement as the AGENA, encompasses the entire field. It includes current and long-range programs such as interplanetary probes, global and space communication systems, and manned space travel.

Engineers and Scientists: The accomplishment of such programs offers challenging opportunities to engineers and scientists in the research, design, development, test and operation phases of these programs. If you are experienced in work related to any of the above areas, you are invited to write: Research and Development Staff, Dept. L-29, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed / **MISSILES AND SPACE DIVISION**

Systems Manager for the Navy POLARIS FBM; the Air Force AGENA Satellite in the DISCOVERER, MIDAS and SAMOS Programs

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ground support equipment

Filter 'Super Cleans' Polaris Fluids

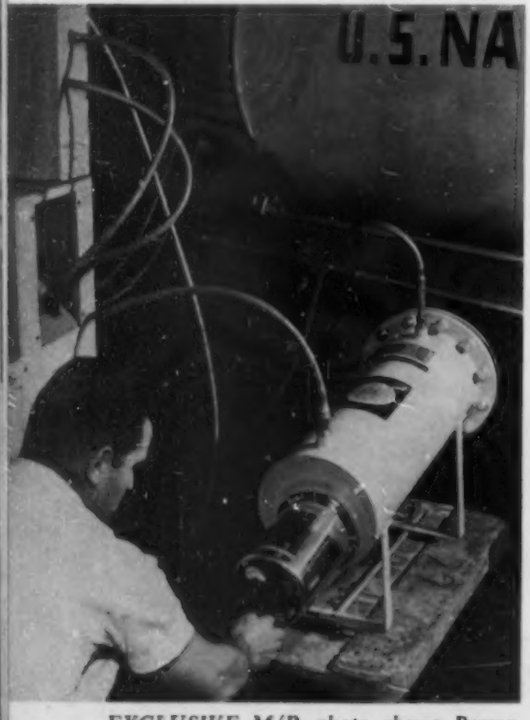
Lockheed reports highly satisfactory results in ground tests of radically different decontaminating method

LOS ANGELES—An electronic filter that makes fluids "super clean" has been developed by Permanent Filter Corp. and is being widely used in the *Polaris* program. Lockheed Missiles and Space Division has been evaluating the filter, designated Perma-Ray, for more than a year and is highly pleased with it.

Robert Lubben, manager of the Perma-Ray Division, said the filter has been in field test for several years, and differs so radically from conventional filtering techniques that there are no military specifications written for it.

The 260-lb filter operates on basic electrostatic principles applying a negative charge to particles in a fluid, which are then attracted to a positively-charged grid and held in the filter. Tests of the unit have produced impressive results of its capability to clean systems of all contaminants.

Two models now being marketed are designed for MIL-5606 and OS45, and other hydraulic and engine fluids of like resistance. (MIL-5606 is the hydraulic fluid used in the *Polaris* and *Minuteman* systems for flight control.) Use with other fluids would require some modification of the power source.



EXCLUSIVE M/R photo shows Perma-Ray filter in use on Polaris ground test.

In the *Polaris* tests, four barrels of contaminated MIL-H-5606 were connected to a ground test unit at LMSD, making a reservoir of about 305 gallons. At a constant temperature of about 140°F and a flow rate of three gallons per minute at 3500 psi, tests were conducted over five eight-hour periods. No filters other than the Perma-Ray were in the system.

S. W. Brewer, LMSD research specialist in reliability and parts application, said the results were extremely favorable. The metal count in the fluid, in the 5 to 15 micron range, dropped from 69,100 particles to 5100 in eight hours. Plastic count, in the same size range, dropped from 21,325 to 3400 particles in eight hours. The gelatin count, also in the same range, dropped from 4550 to 4160 particles in eight hours, and to 105 particles at the end of the 40-hour run.

Particles in the 15 to 50 micron range showed similar drops, and particles over 50 microns were completely removed.

• **Time saver**—In other tests, Permanent Filter said, the unit has reduced the contamination level from an uncountable millipore reading to 690 particles in the 5 to 15 micron range in only five passes.

Brewer said the *Polaris* system once took approximately six hours to completely purge for meeting flight specifications. This is now done much better in 1½ hours with the Perma-Ray unit, he said. Down time thus has been reduced by two-thirds.

Specific advantages over a mechanical filtering system were spelled out by LMSD, which cited the 24-hour period required to clean ten gallons of MIL-H-5606, versus the 1½ hour average time of the new device for the same amount. Other improvements were in down time from filter changes, low flow rate of mechanical filter systems, and element breakdown which re-contaminates the system.

"We installed the Perma-Ray units in July here," Brewer said, "and since then we have never had any down time on them, have never had to change an element, and they've given us cleaner hydraulic systems than we've ever had."

• **Safeguard**—An interlock is available to immediately turn off a system pump, in event of power failure at the filter unit. This prevents contaminants from being forced through the inoperative filter by an active pump.

"We've learned that you can't ever get a system 100 percent clean," Brewer commented, "because simply turning on a hydraulic pump may increase the contaminant content in any system up to 400 percent, due to metal being shaved, or other foreign matter being sloughed off the internal parts of the system."

LMSD has purchased over 15 of the Perma-Ray filters to date, and has recommended that the Navy install them on fleet ballistic missile submarines and subtenders to provide the filtering required.

"This is a sophisticated unit," Lubben pointed out, "and shouldn't be used where regular filtration systems can satisfactorily perform. We think it should only be applied where extreme levels of decontamination are needed."

In its grid design, the Perma-Ray operates through a concept of precharging the particles and routes the fluid on a twisting course through the device, so the fluid is in intimate contact with the filter element and has maximum exposure to the electrostatic field.

In addition to the grid system, a special porous media is used to reduce the velocity of individual particles in the fluid. Intermittently, grids establish a number of fields of flux, alternately negative and positive throughout the length of the porous media and the filter element.

The field within the element is established by a power supply with a 15,000 volt, five milliampere DC output, having a 110 or 220 volt AC input. Variations in this setup would be made with changes in the fluid to be handled by the filter.

An on-stream, multi-pass system, the Perma-Ray has no absolute micron rating, but the company says it will remove more contaminant from MIL-H-5606, particularly sub-micronic particles, than any mechanical filter can. This in addition to great holding capacity, minimum pressure drop and extremely low maintenance.

Some 97.6% removal of all particles is achieved within ten passes, Lubben estimated, emphasizing that the Perma-Ray is not an absolute filter. ⁂

In ARS papers . . .

All-solid Craft Urged for Moon Trip

A PROPOSAL FOR an all-solid space vehicle to land a man on the moon by 1967 was one of the technical highlights of the ARS meeting in Washington. Total cost of the lunar vehicle was put at $2.3 billion.

Two Grand Central Rocket Co. engineers, H. L. Thackwell and R. M. Pierce, presented the all-solid plan which, they said, would provide for R&D and flight of 100 five-stage vehicles, each capable of orbiting 250,000 lbs. of payload. Their development plan calls for 60 R&D engine tests and 15 flight tests before the vehicle would become operational for lunar landings by 1967.

Thackwell's paper outlined a series of three all-solid vehicles based on a Tinkertoy-like series of buildups from a basic propulsion module. The final stage of each vehicle would be a single segment weighing 119,000 lbs. and generating a thrust of about 225,000 lbs. for 70 seconds. A circular head would be attached to each end to accommodate a cap on one end and a nozzle on the other. This basic single-cylinder unit was designated Design I.

The rest of the vehicle would be made up of motors similar to Design I but with a larger nozzle and consisting of five thrust segments. This Design II motor would weigh 464,000 lbs. and generate a thrust of 1,128,000 lbs. A single Design II engine would be the next-to-last stage of each vehicle in the series.

The authors proposed three space boosters built with these basic modules:

–Type A –A 3-stage vehicle boosted by four Design II motors with a stage weight of 1,856,000 lbs. and takeoff thrust of 5,640,000 lbs. Would be available for routine flights in four years and have an orbital lift capacity of 30,000 lbs. Total cost of R&D and flight of 100 production models would be $612 million, or $204 per lb. of payload in orbit.

–Type B –A 4-stage vehicle made up of a type A on top of an 8-engine cluster of Design II engines. Stage weight would be 3,712,000 lbs. and takeoff thrust 11,250,000 lbs. Available for routine flights in 4½ years and have an orbital lift capacity of 100,000 lbs. Total cost of R&D and flight of 100 vehicles would be $1,171 million, or $117 per lb. of payload in orbit.

–Type C –A 5-stage vehicle consisting of a type B boosted by a cluster of 16 Design II motors. Stage weight would be 7,424,000 lbs. and takeoff thrust 22.5 megapounds. Total cost, on a basis of 100 vehicles, would be $2,349 million, or $110 per lb. of payload in orbit.

Big pitch for the all-solid concept is simplicity and high production rate with relatively low costs. Vehicle C, for instance, consists of 147 identical propulsion units, 28 identical nozzles, 58 identical case heads and 29 identical caps. The loaded cylinders would be transportable by truck, rail, or air.

• **Communications satellites** — A wide divergence of opinion as to the most practical communication satellites was evident at the meeting.

A proposal by a Hughes Aircraft Co. scientist for a privately launched 24-hour satellite drew potshots during a panel session. H. A. Rosen, of Hughes, wants to launch the satellite with a *Scout* vehicle from Jarvis Island, an American-owned island 1300 miles south of Honolulu, near the equator.

J. R. Pierce of Bell Telephone Labs said Bell prefers low-altitude active repeater satellites because of the echo problem in a transmission of 45,000 miles (for a 24-hr. satellite) and to get improved signal strength.

Both Bell and Hughes expect to have satellites ready for launching next fall.

Edward Allen, chief engineer of the FCC, said he was confident that radio frequency spectrum space will be found for experimental and operational communication satellite systems.

• **Underwater propulsion**—A novel underwater propulsion unit developed by Naval Ordnance Test Station was described in a paper by W. D. White. Either liquid sodium or lithium is used as a fuel and sea water as oxidizer and dilutent in the unit remarkably blueprinted by Jules Verne. (In "20,000 Leagues Under the Sea," Verne called for sodium to power his fictional Nautilus.)

Theoretical and experimental work has shown that a specific fuel consumpsion of 1.5 lbs. per shaft-horsepower hour is possible with the use of lithium, and less with sodium. A combustion chamber for burning these fuels was developed and operated for three minutes at 95% combustion efficiency and at about 1000°F.

• **Ground support equipment**—Literally the biggest item of GSE discussed at the ARS meeting was that for *Saturn*. Pointing out that a program of this magnitude cannot tolerate any failures due to the GSE, Georg von Tiesenhausen of Redstone Arsenal said that lack of precedent and stringent time schedules put an unusually heavy responsibility on the GSE project engineer. Problems have been solved, however, he said, and the equipment now stands ready to transport, check out, and launch the *Saturn*.

Space suits for lunar explorers are now *passé*, according to a paper presented by two AMF scientists. They contended that research shows that robots and one- and three-man articulated capsules would be more practical for the moon explorer than individual space suits.

A Boeing engineer, describing silo launch tests of the *Minuteman*, said that this phase of the program was ahead of schedule and required only two-thirds the number of firings originally planned. Success was attributed to "thorough analytical preparation" and "exceptional success" in data acquisition.

• **Advanced materials**—High-temperature materials dominated the structures section of the meeting. R. T. Swann of NASA took the position that re-entry heating conditions can best be met by composite systems. Swann analyzed simple and composite systems in relation to weight and found that the latter would require less weight for all heating conditions.

Another approach involving the application of organic plastics in achieving an effective re-entry heat barrier was advanced by B. Forcht and M. Rudick of Chance Vought. The essence of the system is the development of a char layer on leading surfaces. The speakers said it would be possible to tailor a wide variety of composites of reinforced carbonaceous materials —with the necessary properties designed into the structures.

A. R. Maloof described Avco RAD's family of tungsten-based composites which are capable of operating above the melting point of tungsten. Designated Avcomet, the material is particularly suited to withstanding the high heat fluxes found in the throats of present and future full-scale rocket nozzles.

An interesting concept in reinforced

(Continued on Page 48)

Another "impossible" job done by the Airbrasive...

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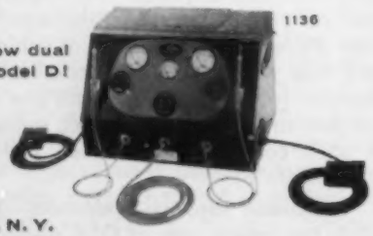

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Civil Defense

(Continued from Page 17)

support of Tactical Command in a brushfire war.

In the event of nuclear attack, the U.S. Defense Command would mobilize to save lives, maintain order, and get the country going again. In this set-up, the present Civil Defense (shorn of useless job-holders) would became the Military Government section of the Command. It would include police, fire-fighters, and CBR teams.

Some National Guard generals dislike the thought of this mission. But let's face it, if we are ever clobbered by nuclear-tipped rockets, members of the National Guard will be fortunate to get to their armories, much less gather in encampments to be shipped overseas as part of an expeditionary force.

• **Stay home and survive**—Drastic revision of present civil defense tactics must take place to give the people a realistic hope for survival.

The key to American civil defense is a national home shelter program, coupled with fast and secure communications, truthful information swiftly relayed to the public, and accurate radiation data. Our situation is different from Russia's. We are committed to receive the first blow, which means we probably will have no chance to evacuate the great cities. Our population centers are more vulnerable than Russia's. Russian targets are dispersed over the whole continent of Asia. So home shelters are the answer for America.

In a surprise attack on our unprepared population today, radiation would kill more people than heat and blast. An adequate home shelter program, privately financed with Federal encouragement, would save most of those who otherwise would die.

Evacuation of cities can be effective only if the populace receives considerable advance notice of impending war. In the event of a pre-emptive strike—which is what we must expect—evacuation would only compound chaos.

• **Swimming pools come first**—Thus far, our shelter program has been a fiasco. In Orlando, Fla., for example, a company specializes in home shelter construction. Florida is more sensitive to the need for shelters than most states, perhaps because of its proximity to Castro's Cuba, and the fact in Florida are so many SAC bases and Navy air installations. Yet this company is struggling, while builders of swimming pools prosper. Hundreds of pools are sunk for every shelter.

In a Florida town, the County Civil Defense Director was asked whether he had any new booklets on fallout. "I had them," he said, proudly, "but I got rid of 'em. Scare people to death if I passed them out!"

• **What government can do**—If the Federal government is really serious about saving the civilian population, it must give concrete encouragement to a home shelter program. The following measures have been presented to the Symington Committee for consideration:

1. Everyone receiving an FHA or VA loan for construction of a new dwelling must agree to include a shelter. Every FHA loan for remodelling should include a similar clause.

2. Cost of shelter construction, either in old or new buildings, should be allowed as a tax deduction, once the shelter has been approved by U.S. Defense Command inspectors.

3. Shelters can be used for dual purpose, such as utility or storage rooms, and this should be encouraged. In many cities parking garages are being built underneath new apartment houses, and will serve a double purpose as a shelter.

4. (And perhaps most important.) Tell people the truth about what nuclear war and fallout means to them, personally. It should be emphasized that they can survive (barring a direct hit within a few miles) and that it is their duty to survive. They have a duty to themselves, their children, and their country. Much apathy is caused by a sense of fatalism and resignation. You hear statements like, "Everybody's going to die anyway," or "I'd rather be dead than lose everything I've worked so hard for."

5. If filling stations and chain stores can afford to pass out trading stamps to their customers, than the Federal government can and should donate a simple, sturdy dosimeter to everyone who spends his cash on a home shelter. Without a dosimeter, you can't tell the score. Fallout varies wildly within a few miles, and an official testing station in the next big town may give you a wrong answer.

These seem minimum requirements for encouraging construction of home shelters. For a realistic civil defense program, other immediate measures are necessary.

• **Conelrad's obsolescence**—Conelrad should be scrapped at once. It no longer serves any useful purpose and indeed may inhibit exchange of news and information within the country.

Conelrad was started in 1948, at the request of the Air Force, to prevent enemy bombers from finding a target city by homing on a radio station. All

(Continued on Page 40)

NEW CAREER OPPORTUNITIES FOR ENGINEERS & PHYSICISTS

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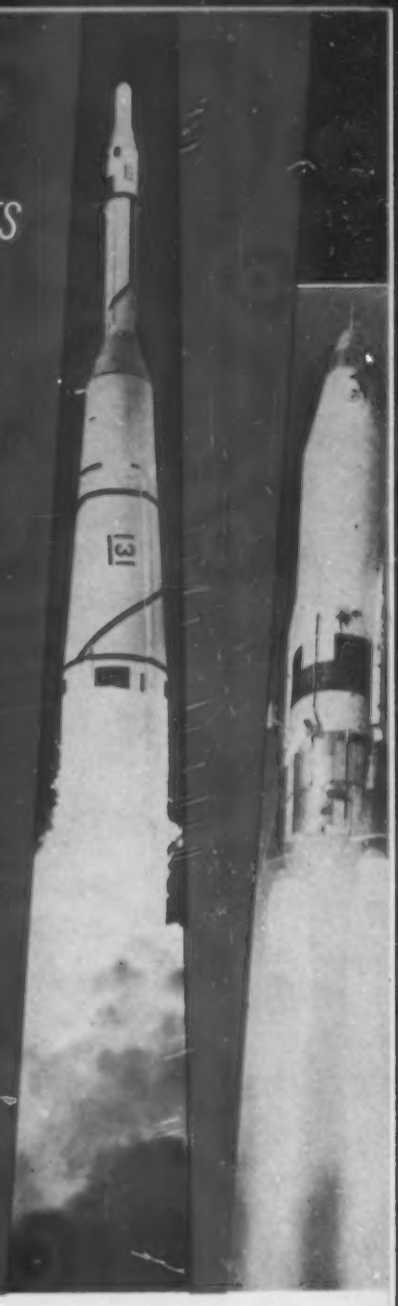

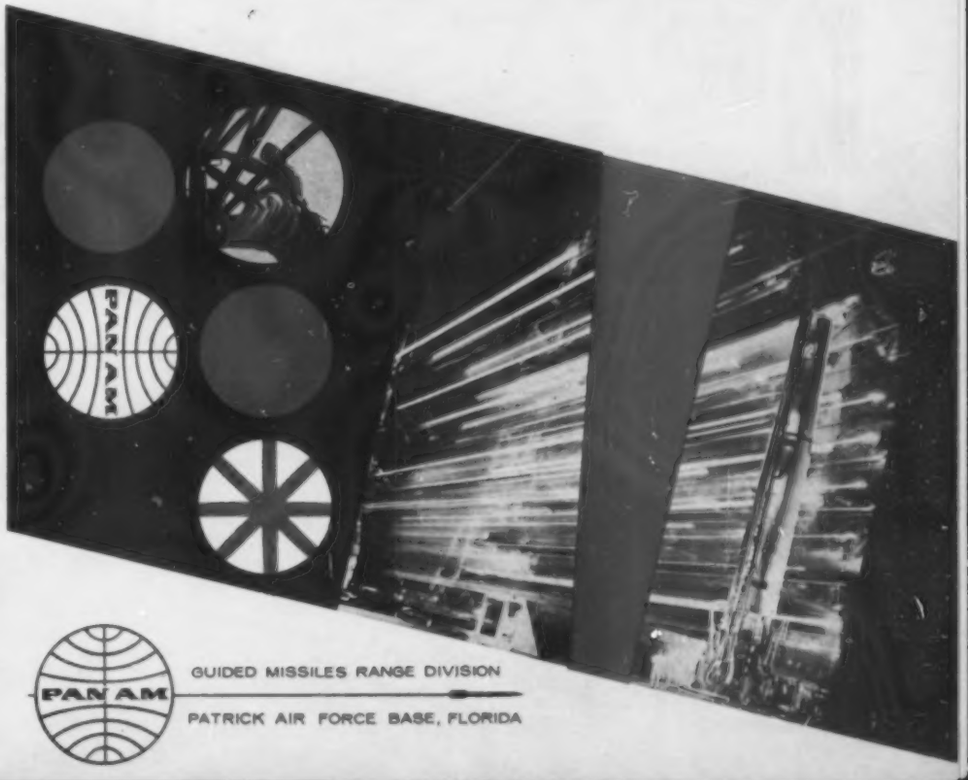

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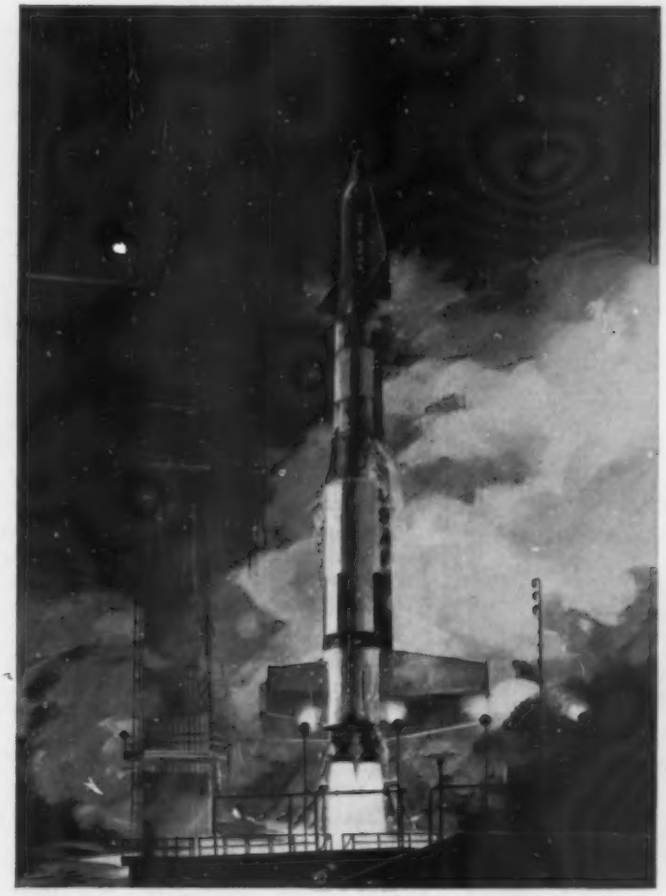
PAN AM
GUIDED MISSILES RANGE DIVISION
PATRICK AIR FORCE BASE, FLORIDA

BULLETIN FROM BOEING ...

...WHERE CAPABILITY HAS MANY FACES

Expanding the frontiers of knowledge through basic research is the business of the Boeing Scientific Research Laboratories, left. Here Boeing scientists are at work in the fields of solid state physics, flight sciences, advanced mathematics, plasma physics and geo-astrophysics.



SPACE GLIDER. Artist's concept shows Dyna Soar manned space glider perched atop modified Titan ICBM for launching. In space, the glider and booster would separate, leaving Dyna Soar vehicle in piloted, near-orbital flight. Pilot could later glide to conventional landing at a selected base. Dyna Soar is being developed by the U. S. Air Force in cooperation with NASA, with Boeing as prime contractor for both the system and the glider.

FUTURE SKYLINER. Boeing, builder of famous 707, America's first jet airliner, has long been at work on next generation of aerial transports, which could look like the Boeing design pictured above. Supersonic jetliners, probably a decade away, could have speed in neighborhood of 2,000 miles an hour. Flight time, from Paris to New York, would be about two and a half hours!

SHOCK TUBE. Industry's most powerful shock tube, designed and built by Boeing Scientific Research Laboratories scientists, creates shock waves which begin at 300 times speed of sound, then collide in tube at "slowed" rate of 80 times speed of sound. Gas temperature within the tube reaches approximately one million degrees. Studies could be important in developing effective ion and plasma-propulsion systems for use in space.

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(Continued from Page 37)

Russian bombers are now equipped with modern radar. They don't have to tune in WJZ or WTOP to locate New York or Washington. Rockets, guided and unguided, do not find it necessary to listen to the radio to hit their targets.

In the event of war emergency, all commercial television and all radio except those transmitters on the Conelrad frequencies would cease operations, under present plans. Conelrad broadcasts on very low power, alternating transmitters. As a result, it is often difficult to hear Conelrad broadcasts at all.

In place of Conelrad, powerful clear channel stations should be designated to carry news and instructions to the populace. Anything, including operation of all surviving transmitters, would be better than Conelrad.

• **Keep news flowing**—All radio stations presently receive their news from the Associated Press and United Press International on teletype machines. The main originating and relay points for the two big news agencies are New York, Washington, and Los Angeles, all primary target cities. The biggest AP and UPI bureaus are in those and other of our largest cities, such as Chicago, Houston, Philadelphia, Miami, Detroit, Pittsburgh.

Thirty minutes after attack our major news networks probably would have ceased functioning. The local radio stations would be supplied with news from local officials. Such news would certainly be delayed, and probably inaccurate. Lack of news breeds rumor, and rumor breeds panic. The government should immediately lay an auxiliary news network, avoiding the target cities, which would be available to AP and UPI come "The Day."

Our lag in civil defense is an open invitation to attack. A realistic U.S. Defense Command would be added deterrent against war. It may seem strange, but the officers and men of SAC seem more concerned with the problem than any other group in the services. It is strange until you consider that the men of SAC know the power of the bomb, intimately, and their families are usually close to targets. ⌘

Pat Frank is the author of many books, articles and short stories dealing with survival in a nuclear war; his most recent is the novel Alas, Babylon. *He is also a former Washington reporter and World War II correspondent. He carried out several wartime propaganda assignments for the U.S. Government and for the U.N. in Korea. During the recent presidential campaign, he was an advisor to President-elect Kennedy.*

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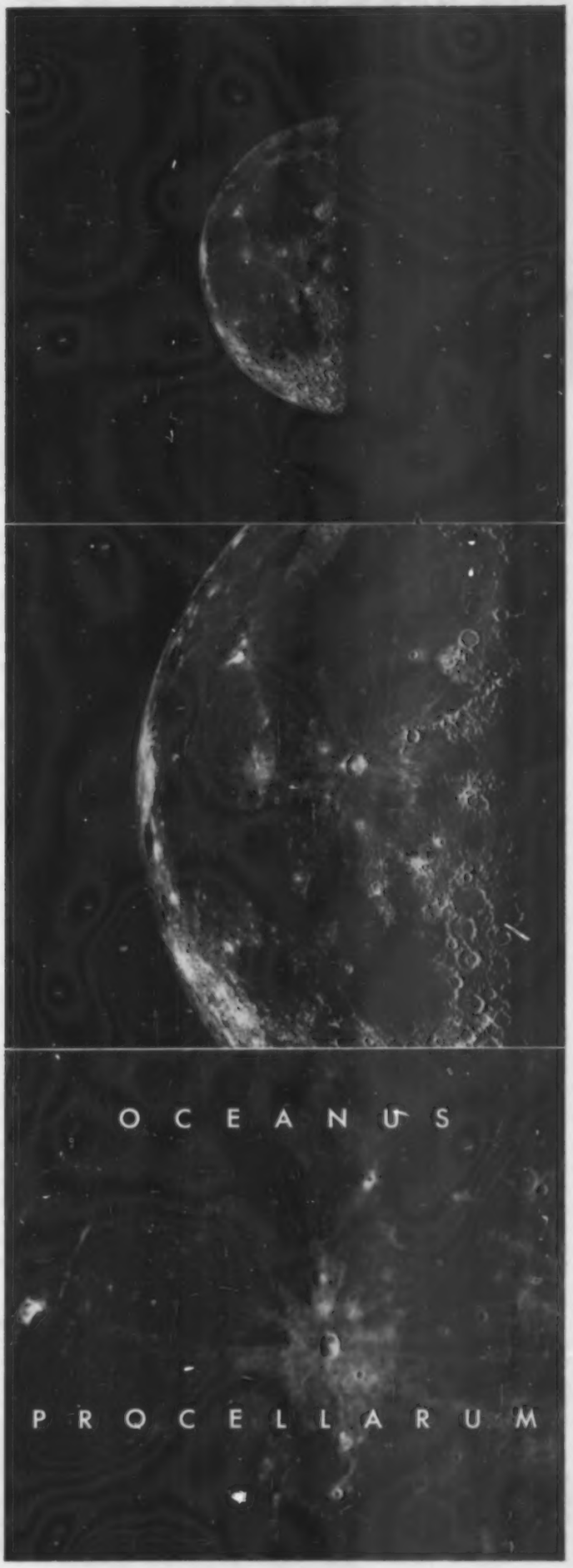

SPRINGBOARD FOR SPACE: LUNA

The moon is a ready-made space station for interplanetary exploration; space vehicles could be built, fueled, and launched there; lunar elements could be used to give man independence from earth. To help make this concept a reality, NAA's Missile Division has integrated the ideas of scientists in many fields and is studying how to reach the moon... how to live in its alien climate... how to process lunar matter. One example: a study of processes to obtain water from materials likely to be found on the moon.

THE MISSILE DIVISION OF NORTH AMERICAN AVIATION, INC.

Downey, California

names in the news

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DEROSA

Ernest L. Ward: Elected president of Sprague Electric Co. replacing the late **Julian K. Sprague.** Ward joined the firm in 1946 as a vice president, was elected to the board of directors in 1947 and, in 1953 was appointed executive vice president in charge of all manufacturing activities.

Dr. Henry Swift: Appointed assistant director of the infrared laboratory at Hughes Aircraft Co.'s Santa Barbara Research Center. Prior to joining Hughes he was an associate director of the Naval Aviation Ordnance Dept. at China Lake, Calif.

Dr. Seymour Stein and **Dr. James E. Storer:** Promoted to senior scientists at Sylvania Electric Products Inc.'s Applied Research Laboratory. They are the first to achieve that position with GT&E.

Andrew L. Larson: Appointed manager of Navy Sales for Lockheed Electronics Co.'s Military Systems Division. Formerly served as a project engineer in the Shipboard Electronics Dept.

Darrell D. DonCarlos: Named manager of by-pass engines and rocket sales for the Allison Div. of General Motors. He replaces **Richard L. Coffey,** appointed manager of the division's Los Angeles zone office.

Joseph M. Rowland, Fred E. Hamlin: Named Corporate Director of Public Affairs and Director of Communications, respectively, at The Martin Co. Rowland was formerly Corporate Director of Information Services and Advertising, and Hamlin Director of Information Services for the Baltimore division.

Austen Madeson: Elected vice president-marketing for Solid State Materials Corp. Prior to joining the firm he was sales manager of the Crystal Filter Div. of Hermes Electronics Co., a division of Itek Corp.

Dr. Samuel Sensiper and **Dr. William Pohlman:** Appointed director and associate director, respectively, of Space Electronics Corp.'s newly formed Command and Control Laboratories. Dr. Sensiper comes from Hughes Aircraft Co. where he served as senior staff consultant in the Research Laboratory and Dr. Pohlman previously served as associate director of systems for the western division of Collins Radio.

Carlos de Moraes: Named program manager of The Martin Co.'s *Apollo* study contract with the National Aeronautics and Space Administration. De Moraes was Martin project engineer for the Air Force *Dyna-Soar* manned aerospace glide vehicle program.

Aaron Blaustein: Appointed chief research and development engineer of De-Jur-Amsco Corp.'s new Research and Development Dept. Was formerly associated with Fairchild Controls Corp. as new products program chief engineer.

George H. Mettler: Elected vice president of Textron Inc. **Charles D. Brown,** former manager-marketing of General Electric Co.'s Instrument Dept., succeeds Mettler as president of MB Electronics, a division of Textron Electronics, Inc.

Carl C. McCallus: Named director of marketing, a newly-created position at Viking Industries Inc. Was formerly director of marketing for Phillip Morris, Inc., and sales manager of Hoffman Electronics Corp.'s Electromechanical Div.

Quentin G. Turner: Chosen at Motorola Inc. to head all managerial aspects of development and production of the M.&T.C. major weapons system for the New North American B-70 triple-sonic global bomber. He will retain his position as assistant manager of Motorola's Western Center.

Henry M. DeRosa: Appointed vice president in charge of marketing for Vector Manufacturing Co. Inc., manufacturers of telemetering components and systems. Was previously associated with Long Island City Co., Infra Electronic Corp., W. L. Maxson Corp. and Bendix Aviation Corp.

Dr. Gordon S. Brown: Dean of the Massachusetts Institute of Technology's School of Engineering, elected to the Board of Directors of Baird-Atomic, Inc.

Dyna-Soar Safety

(Continued from page 29)

• **Drainage**—The technical area of glider drainage of combustible leakage is one in which a considerable effort must be expended. Fluid behavior under zero gravity conditions may necessitate development of specialized drainage systems to insure adequate drainage under all *Dyna-Soar* flight conditions. The complexities of such systems have placed greater emphasis on development of leakproof fluid systems; with the operational environment extremes to be encountered, however, a certain leakage must be anticipated.

It is a design objective to prevent leaking fuels from contacting ignition sources. Among the prevention techniques to be practiced is isolation of combustible areas and protection of potential ignition sources through measures such as maximum use of circuit breakers to prevent electrical circuit overloads and cooling provisions for areas which normally might exceed the autogenous ignition temperature of the leaking fluid.

Design safety approaches to the completing portions of the *Dyna-Soar* system—namely the booster, launch complex, support equipment, and test range—are not unique in themselves but rather are the outgrowth of a tremendous volume of development and service experience.

The booster safety effort for the *Dyna-Soar* program is under the management responsibility of the *Dyna-Soar* Booster Office at BMD. Current efforts in this area include an appraisal of the *Titan* configuration and its suitability for use in manned applications. High reliability has been obtained thus far in the *Titan* ICBM development program. But the modifications to the booster necessary to accommodate the glider must be analyzed to determine their influence on the overall safety and reliability of the booster.

Candidate boosters for future steps of the *Dyna-Soar* program are being investigated. Since these boosters are in the early development phases, the *Dyna-Soar* Engineering Office hopes to contribute to a design safety effort on these vehicles by familiarizing the contractors with the *Dyna-Soar* program and the safety emphasis which is essential in the piloted advanced research system of this type.

The primary protection system in the booster is the malfunction detection system. This is incorporated to monitor selected critical parameters in the booster. Output from these monitor sensors will be summed in

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a logic circuit and if conditions warrant, a signal to initiate escape action will be sent to the control center. A suitable failure detecting system will include a monitoring of critical items within electrical, flight control, propulsion and tankage systems.

The engineering groups in each of these areas have formulated the sensing requirements for each of their systems. Since it is a research program, each subsystem has been heavily instrumented. To insure that an efficient malfunction detection system is selected, the safety engineer must determine what abnormal operations would produce hazardous sequential failures, what available instrumentation could be tied into the malfunction detection system, and which complementary detection devices are required. From this analysis effort a malfunction detection system for the *Dyna-Soar* will be designed to advise the pilot of a pending catastrophic failure and permit automatic or pilot-initiated escape action.

Safety of operations at the launch site and test range will be emphasized through issuance of safety directives to cover each phase of the *Dyna-Soar* flight test program. Excellent information has been prepared for current safety programs at Cape Canaveral and will be used as a guide in establishing the program.

• **Premium is on cooperation**—In the preceding comments, I have attempted to outline the various phases of our program and the precautions being considered to insure that our flight exploration is accomplished with the utmost in safety for man and material. Neither one man, one section, one division, nor one command can make the necessary effort alone. Cooperation must be emphasized; everyone who contributes to the *Dyna-Soar* program must develop an awareness of the hazards involved.

Thousands of individual safety campaigns must be waged if this country is to successfully conquer the challenge of space. A safety program is never completed but must continue throughout the life of the system. As the *Dyna-Soar* program progresses, unique hazards will develop and means of neutralizing them must be found. Technology in the area of development and operational safety must proceed at a pace paralleling advancements in propulsion, high-temperature materials, and other essential areas. The *Dyna-Soar* program is attempting to meet this challenge. Subsequent advanced systems programs must continue this effort. ⌗

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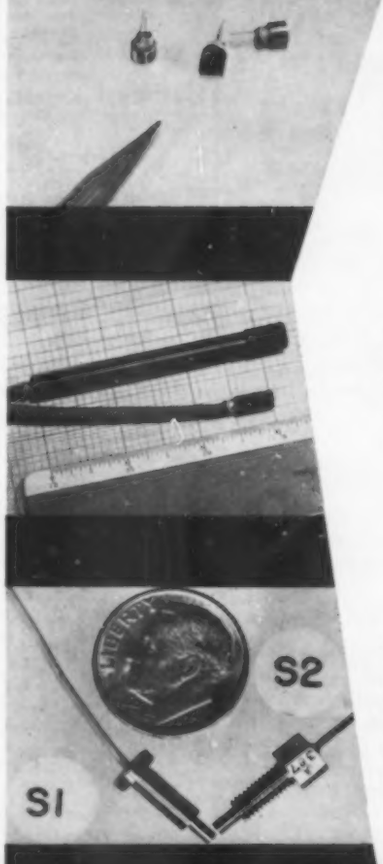

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contracts

AIR FORCE

$65,000,000—Hughes Aircraft Co., Culver City, Calif., for production of the *GAR-11 Nuclear Falcon*, the radar-guided *GAR-3A* and the infrared-seeking GAR-4A *Super Falcon*.

$6,000,000—Ling-Temco Electronics, Inc., Temco Missiles & Aircraft Div., for manufacturing major components for the B-52H manned missile-launching platform. Subcontract from **Boeing Airplane Co.'s Wichita Div.**

$1,100,000—Sperry Gyroscope Co., for flight computer directors.

$689,479—Collins Radio Co., for horizontal situation indicators and amplifiers.

NASA

$31,000,000—Linde Co., Div. of Union Carbide Corp., for liquid hydrogen to be used in future space projects on the West Coast. Linde will deliver liquid hydrogen to the West Coast from an Air Force plant at West Palm Beach, Fla., until a new company plant at Fontana, Calif., gets into production in mid-1962.

ARMY

Tele-Dynamics Div., American Bosch Arma Corp., Philadelphia, for study of low-level wind measuring techniques. Amount not disclosed.

$20,428,000—The Martin Co., Orlando, for continuation of engineering services and development of long lead-time equipment for the *Pershing* system.

$2,250,000—Raytheon Co., Bedford, Mass., for further research and development work on the *Hawk* system.

$1,900,000—Fairchild Engine & Airplane Corp., Hagerstown, Md., for AN/USD-5 drone surveillance system.

NAVY

Custom Systems Corp., Santa Ana, Calif., for production of special underwater electrical cable systems. Amount not disclosed.

reviews

PROCEEDINGS OF THE 1959 COMPUTER APPLICATIONS SYMPOSIUM, Armour Research Foundation of Illinois Institute of Technology, sponsors. 155 pp., $3. Order from Armour Research Foundation, MF:CA6, 10 West 35th St., Chicago 16, Illinois.

The Proceedings contain 14 invited papers presented at a two-day meeting in Chicago, and the edited text of the associated discussions. The first day's papers were devoted to business and management applications, and those on the following day stressed engineering and scientific applications.

Several themes were represented. One was the development of methodology of general interest to exploit the capabilities of specific machines, large to small. Another was the extension of a general-purpose computer's resources by means of specialized input-output and display equipment to handle graphical information.

The largest group of papers, and a considerable portion of the panel discussions, were addressed to the question: Now that we have the machines, how do we communicate with them? The answers centered around the pros and cons of automatic programing and language design. Finally, there is a report on the current status of computer technology in the U.S.S.R.

EMBRITTLEMENT BY LIQUID METALS, W. Rostoker, J. M. McCaughey and H. Markus. Reinhold Publishing Corp., N.Y., 162 pp., $7.95.

A new approach to embrittlement by liquid metals based on modern dislocation theories of brittle fractures emerges from this synthesis of the vast amount of information in the field.

The aggregate knowledge in the literature was found to be inadequate and often inaccurate. The authors enlarged upon this store through research sponsored by the Army. Most of the information in the volume has not been published previously since the authors felt that presentation in the usual journals would result in incomplete and inadequately correlated communication.

Radar/Transponder Checkout Units

An airborne test set designed for pre-flight or in-flight checkout of IFF transponders or ATC radar beacon performance is available from Stromberg-Carlson, a division of General Dynamics Corp.

Designated Model SC-770, the test set provides a "go" or "no-go" indication of transponder operation. It is compact in size, weighing less than 3 pounds, and consists of two parts—the basic interrogator circuitry, and the control box for instrument panel mounting.

To operate the test set it is merely necessary to push a button on the control box, which interrogates the transponder. A satisfactory response from the transponder will cause indicator lamps to flash. Use of solid state devices in the unit keeps power requirements extremely low.

Circle No. 225 on Subscriber Service Card.

Portable Ozone Recorder

A portable ozone recorder, available from Mast Development Co., measures and records ozone concentrations on a 6 in. strip chart.

The instrument's major components are the Model 724-1 Ozone Meter, a strip chart recorder and a weatherproof case. The weatherproof case enables stationing the ozone meter at remote outdoor locations with the strip chart recorder located in the laboratory for observation. The unit employs a highly efficient Micro-Coulomb sensor which eliminates buffer solution composition criticality.

Circle No. 226 on Subscriber Service Card.

Single Side Strain Gage

A bending-separator gage which will separate and identify tensile strains and strains produced by bending moments on the surface of a structure is available from The Budd Co.

Major feature of the device, called FLEXAGAGE, is that it can be mounted on one side of a structure only.

FLEXAGAGES can do all jobs of back-to-back mounted strain gages, including: locating the neutral axis of the shell-skin-plate and detect buckling. Maximum error without correction factors for gages used as specified is 2%.

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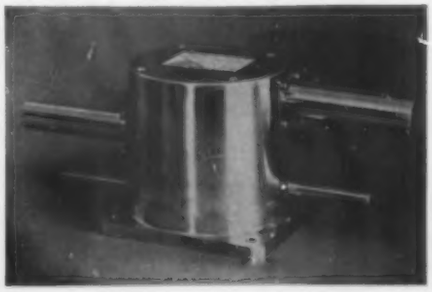
Pressure Regulator

A precision gas regulator which controls pressure at any selected remote point in a pumping system is available from Del Monte Technical Associates.



The Mark II Pressure Regulator is a self-contained, instrument quality device which can be used in both vacuum and pressure applications. Regulation is typically within ±0.1 mm Hg from minute rates of flow up to 30 cfm.

Circle No. 228 on Subscriber Service Card.

Subcarrier Oscillator

A transistorized subcarrier oscillator designed for operation from millivolt signals and having a transformer-coupled, floating input is available from Electro-Mechanical Research, Inc. Model 199B is designed for reliable operation in FM telemetering systems incorporated in missile or aircraft environments.

The oscillator operates in any IRIG-standard telemetry channel from 2.3 to 22 kc. Frequency deviation is a linear function of input voltage within ±0.2% of the best straight line on IRIG channels 7-14. Common-mode rejection is better than 100 db.

Circle No. 229 on Subscriber Service Card.

Space Heating Elements

A film type, inorganic heating element, is available from Thermo-O-Lab Corp. It does not out-gas in a vacuum and it is stable at –400°F. The element does not glow or support combustion.

Only .015 in. thick, it is sprayed on to any shape. It is completely inorganic; and acceleration, vibration, radiation and cryogenic temperatures provide no problem.

Circle No. 230 on Subscriber Service Card.

Miniature Clutch

A high-efficiency miniature magnetic clutch with a minimum torque rating of 10 ounce-inches at speeds to 1000 rpm is available in four voltage ranges from Ultronix, Inc.

The firm's Model 162 clutch is stocked in 6, 12, 28 and 90 volt ranges,

all operating at 2.5 watts. The unit occupies about 1 cubic inch. Torque loss with stainless ball bearings is less than 0.3 ounce-inch. Field shaping and the steel-to-brass clutch face enables the clutch to deliver up to 15 ounce-inches to the load at 2.5 watts.

Circle No. 231 on Subscriber Service Card.

Plasma Gun Convertor

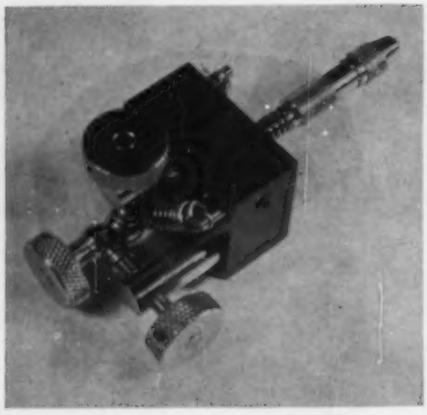
A conversion kit which permits the modification of any standard Plasmatron SG-1 hand held plasma spray gun to variable arc temperature use is available from Plasmadyne Corp., a subsidiary of Giannini Scientific Corp.

The kit permits adjusting the jet temperature between 300°F. and 30,000°F., by changing the distance the adjustable rear electrode projects into the throat of the front electrode and by adjusting the insulated rod to which the rear electrode is mounted.

Circle No. 232 on Subscriber Service Card.

Wafer Manipulators

The Micromanipulator Co. has available models 100 (right hand) and 200 (left hand) micromanipulators—useful in semiconductor and related



work for the precision positioning and probing of wafers and microelectronic assemblies. Accessories include tungsten probes and phenolic insulating jaws.

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Low Frequency Absorbers

McMillan Industrial Corp. is marketing TYPES BB and BP broadbanded absorbers providing effective attenuation in free space room installations from 35,000 mc/s down to as low as 50 mc/s in the case of the BB-96.

Major advantages are: elimination of any supporting structure; a reduction in cost per unit volume of absorber, rugged, fire-resistant construction, and reduction of shipping and storage space (and hence cost), since in shipment they occupy a fraction of their installed volume.

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Miniature Relief Valve

Benbow Manufacturing has available an inverted design miniature relief valve which eliminates over-travel, chatter and slamming while maintaining desired system pressure.

Specifications exceed requirements of MIL-V-5523 with zero leakage internally; 100-PSI to 4000 PSI with wide adjustment; flow rate 0.5 to 6 GPM; temperature range −65 to +250°F.

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Motionless Explosive Switch

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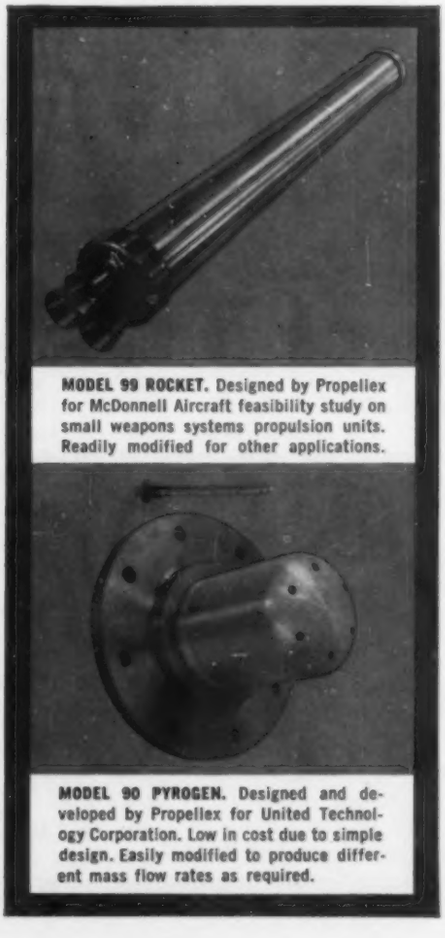

MODEL 99 ROCKET. Designed by Propellex for McDonnell Aircraft feasibility study on small weapons systems propulsion units. Readily modified for other applications.

MODEL 90 PYROGEN. Designed and developed by Propellex for United Technology Corporation. Low in cost due to simple design. Easily modified to produce different mass flow rates as required.

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completion of the circuit. The switch will withstand unlimited G-force, shock and vibration, both before and after contact is completed.

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Isolated Input Amplifier

A floating differential DC amplifier which provides complete isolation of input signal from amplifier output and chassis ground is available from Neff Instrument Corp.

Designed specifically for amplification of DC signals from strain gages, thermocouples, and bridge-type transducers, the new Type 1-104 Amplifier offers Common Mode rejection of 180 db at DC, 130 db at 60 cycles with up to 1000 ohms line unbalance. Stability is 5 microvolts over a six-month period.

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Navy Standard Containers

All 28 sizes of the Navy's standardized aluminum containers are available from Zero Manufacturing Co. They are constructed to Navy BUWEPS Drawing List 2210448 and also meet specifications of MIL-T-945A, MIL-T-21200. These containers are equipped with standard latches, pressure equalizers and humidity indicators. Easy to accessorize, they are readily adaptable for other uses where rugged, watertight, air-tight containers are required.

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Acceleration Switch

A model AS-4 switch is responsive to acceleration in one direction along a single axis, is available from Eastern Technical Associates. Resetting is by means of high acceleration in the opposite direction or manual reset. The design is rugged and simple consisting of only one moving unit within the switch housing. The housing is constructed of aluminum and interior construction can be of non-magnetic materials resulting in a completely non-magnetic component.

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Compact Recorder

A compact, lightweight 8.5 x 11 in. X-Y recorder is being marketed by F. L. Moseley Co. Model 135 features built-in calibrated X-axis time sweeps, plus 16 calibrated ranges on each axis, with an infinitely variable vernier. The Model 135 features high input resistance, a self-contained vacuum paper hold-down, full range calibrated zero set and zero suppression on each axis, plus high recording speed.

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No exception is the Bristol Syncroverter* chopper used in the TARTAR's guidance system. The TARTAR, produced for the Bureau of Naval Weapons by Convair (Pomona) Division of General Dynamics Corporation, is slated to form the primary antiaircraft weapon aboard destroyers and secondary antiaircraft batteries aboard cruisers.
The Bristol Syncroverter chopper has a long history as a component in U.S. guided missiles. It's the ideal miniature electromechanical chopper for use in d-c analog computers or wherever utmost reliability is required.
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LONG RANGE INPUT / 1794

News of the recapture of Condé from the Austrians was sped to the French Revolutionary Convention at Paris in a matter of minutes via Claude Chappe's amazing télégraphe aérienne, or relay aerial telegraph, Sept. 1, 1794. A new era in rapid communications had begun.

Today, instantaneous and completely reliable Electronic Communications insure the immediate and continuous interchange of intelligence throughout the Free World. ECI is proud of its initiative and responsibilities in the design, development and manufacture of high precision electronic equipment to the critical specifications required in various aerospace and surface roles vital to our National Defense and to scientific achievement. An example is ALRI—Airborne Long Range Input—a program where ECI communications and data link equipment fill an integral and essential requirement in linking USAF's advanced early warning system to SAGE—our continental defense network.

One of a series depicting historic incidents in military communications

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ARS Technical

(Continued from Page 35)

plastic art was presented by I. Gruntfest and N. Dow of General Electric MSVD. They proposed replacing the usual solid-glass fiber with hollow glass of comparable outside diameter.

• **Navigation and guidance**—The use of favorable geometric properties of lower-magnitude star distribution over the celestial sphere was proposed by N. S. Potter of W. L. Maxon Corp. as a solution to certain weaknesses (such as tumbling) in conventional star-tracking techniques for sensing in inertial space.

The 157-lb. inertial system developed by Minneapolis-Honeywell and Librascope for *Centaur* injection guidance was described as providing high accuracy, broad mission flexibility, and complete vehicle attitude and coast freedom—all with minimum cost and developmental time. The 32-lb. inertial platform is a 4-gimbal platform with three one-degree-of-freedom gyros. Other units include an 18-lb. guidance electronics unit, 50-lb. pulse-rebalance and power supply package, 10-lb. signal conditioner (for telemetry), and a 57-lb. digital magnetic-drum computer.

Saturn-boosted space vehicles will use the Delta-Minimum inertial guidance system developed for *Redstone* and *Jupiter*, according to a paper delivered by W. Haeussermann, of NASA. It was chosen, he said, because its proven accuracy and reliability were essential to meet the "almost universal" requirements of the *Saturn* vehicle.

SATRAC (Satellite Automatic Terminal Rendezvous and Coupling) was proposed by Convair's L. J. Kamm for the automatic guidance, soft impact, and connection of two space vehicles, manned or unmanned. Primarily optical, the homing system would employ pulsating lamps mounted on booms set at right angles to the flight path. ⁂

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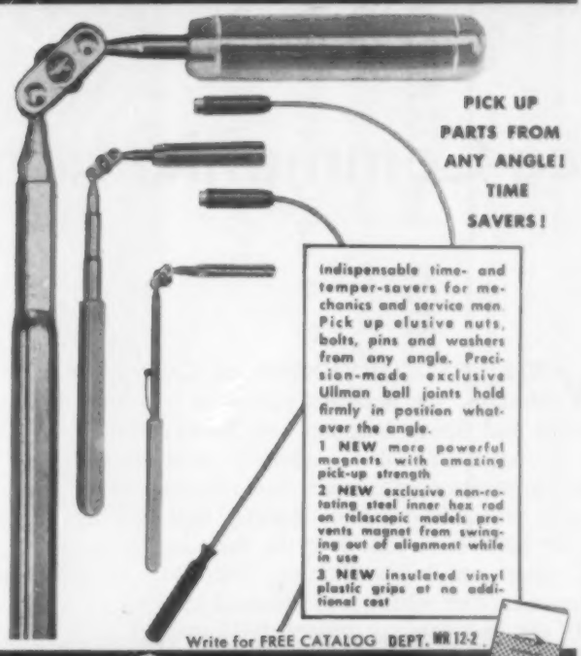
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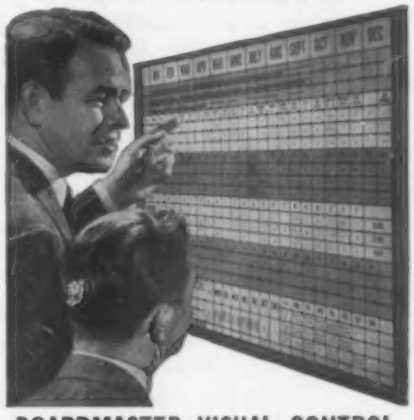

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editorial . . .

Space Communications Outlook Garbled

WITH THE CONVENING of Congress in January, the Senate Committee on Astronautical and Space Sciences can be expected to take a long, hard look at America's position with regard to international space communications.

It is probable, we have learned, that hearings will be held as a follow-up to the Committee's staff report on Policy Planning for Space Telecommunications which was released last week.

If the voluminous report (207 pages) indicated any one thing clearly it was that the U.S. communications situation is confused; that it will continue to get more confused unless some heroic step is taken to combine or centralize the authority (and lack of it) which is now scattered between a number of boards, committees and commissions.

Among the possible peaceful applications of space, two stand out. One is global communications. The other is weather forecasting. And the former plays a great part in the latter.

Neither of these programs is spectacular. Neither puts a man in space or aims at the moon (at least not immediately). But both are eminently important. Both have military applications but both also have applications for other government agencies and for commercial users.

Without coordination there is the great possibility that we may, in our preoccupation with details, miss the bigger things, especially those in the communications field.

With the release of the Senate Space Committee report came the announcement from NASA that the space agency would enter the field of active communication satellites. In the past NASA has confined its activities to passive types (the *Echo* balloon) and left the repeater satellite field to the Department of Defense.

In addition, NASA said: " . . . support will be given to technically promising private proposals on a cost-reimbursable basis. This means that NASA will, to the extent of its statutory authority, make vehicles, launching and tracking facilities and technical services available at cost to private companies, provided the private plans for the development and commercial utilization of communication satellites are technically promising and in general consonance with the requirements of other licensing bodies."

We would not for a moment doubt that everyone involved in the U.S. space communications area has the best of intentions.

WE WOULD POINT OUT, however, that at this moment the responsibility for the planning and aiding of such communications is divided between—to name some—NASA, Defense, State, Bureau of Budget, the Federal Communications Commission, Civil Defense, the U.S. Information Agency, the Telecommunications Coordinating Committee and the Interdepartment Radio Advisory Committee.

We would also suggest that there is no one office at White House level (from where else could such a group be commanded?) which establishes policy and priorities for space communications. We further suggest that there should be.

All of the agencies named are bureaucratic. And men in bureaucratic agencies tend to act like bureaucrats unless someone higher pushes, prods and cracks a whip.

The President's Space Policy Committee might have fulfilled this requirement—if it had been made to function as the Congress intended it to. It never has.

To this void, to this delinquency in our space program, we invite the attention of the Senate Space Committee and the Chairman who will succeed Vice President-elect Lyndon Johnson. It is a rich field for inquiry.

Clarke Newlon

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New Magnetic Orientation Device—a revolutionary advance to capitalize on the effects of the earth's magnetic field on TIROS II and maintain favorable orientation of the sensors over an extended period of time.

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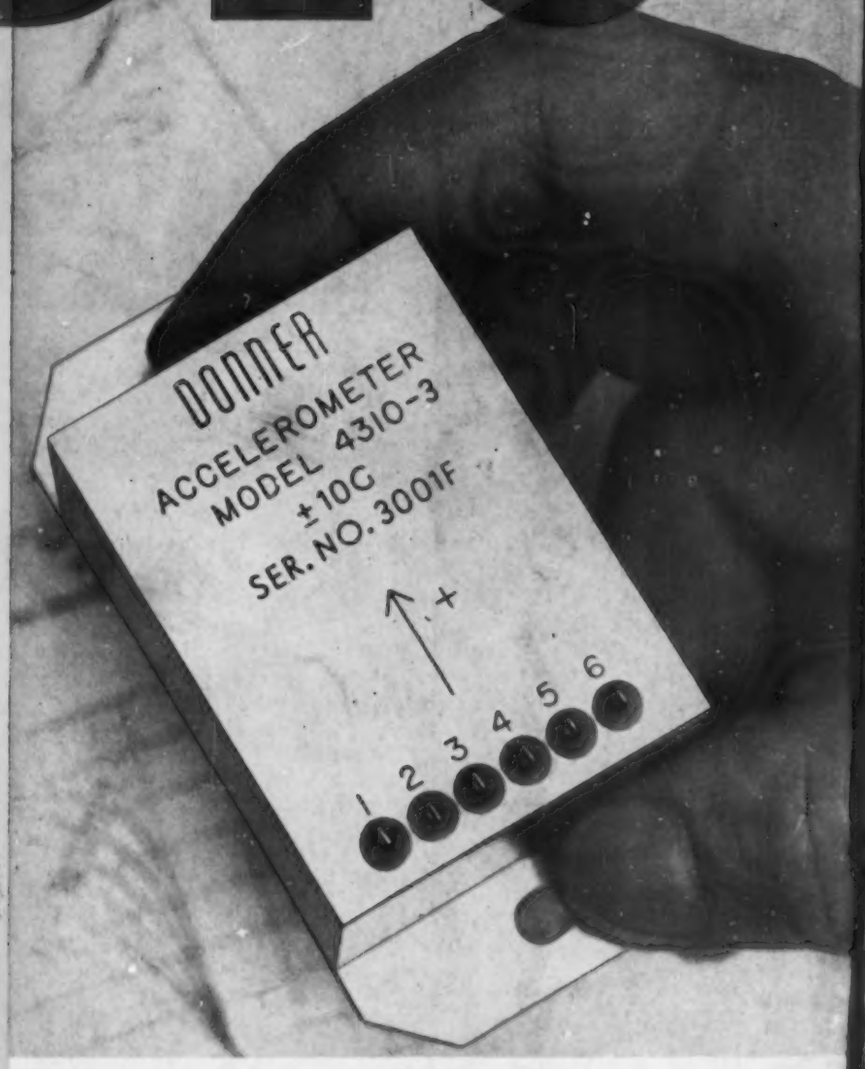

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